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Previous References

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Later References

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General and Revenue Secretariat.

Serial No. 4

Part B for Nov. 1930

SUBJECT.

Rules etc for the recruitment in India by examination for the inferior Telegraph Engineering & Wireless Branches of the Indian Ports & Telegraphs department

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Pol. 533

OFFICE OF THE HON'BLE THE
RESIDENT IN MYSORE,

Bangalore, 1st ~~October~~ November 1930

No. 8324 Enc 4
180-1926.

PP 42-30-4.
CS 1629

A copy of the marginally noted paper is forwarded to the Chief Secretary to the Government of His Highness th Maharaja of Mysore, for information, in continuation of the endorsement from this Residency No.4207, dated the 21st May, 1930.

Reprint of rules for the recruitment in India by examination for the Superior Telegraph Engineering and Wireless Branches of the Indian Post and Telegraph Department.
Syllabus of the examination for the Indian Service of Engineers the Indian Railway Service of Engineers and the Superior Telegraph and Wireless Engineering Branches of the Posts and Telegraph Department in the compulsory and optional subjects.

PP
8/11/30

for SECRETARY TO THE RESIDENT.

Subd of perusal
4/11/30.

5/11/30

PN

6 S 28. Mysore

RULES FOR THE RECRUITMENT IN INDIA BY EXAMINATION FOR THE SUPERIOR TELEGRAPH ENGINEERING AND WIRELESS BRANCHES OF THE INDIAN POSTS AND TELEGRAPHS DEPARTMENT.

(Reprinted as amended up to August 1930.)

1. A competitive examination for admission to the permanent establishment of the Superior Telegraph Engineering and Wireless Branches of the Indian Posts and Telegraphs Department, shall be held in India at such time and place as the Governor General in Council may direct.

2. Of the total number of vacancies in a year to be filled in India by examination under rule 1, two-thirds will be filled on the results of the competitive examination in the direct order of merit, provided the number of candidates is declared by the Public Service Commission as having qualified by examination. The remaining one-third vacancies will be reserved by the Government of India to redress, so far as may be necessary, marked communal inequalities and any appointments, which it may be necessary to make on these grounds, shall be made by the Governor General in Council, after consultation with the Public Service Commission by direct nomination from among candidates who have attained the qualifying standard at the examination and have satisfied the Public Service Commission that they are in all respects suitable for employment in the Superior Telegraph Engineering and Wireless Branches of the Indian Posts and Telegraphs Department. Such vacancies, among the one-third reserved, as may not be required for the redress of communal inequalities or for which duly qualified candidates for direct nomination may not be forthcoming may be filled in the direct order of merit in which the candidates passed the examination.

3. From the list, prepared by the Public Service Commission, of competitors, who have in the opinion of the Commission attained the qualifying standard, candidates to the number of vacancies to be filled will be selected for appointment in the manner laid down in Rule 2 provided that the Government of India are satisfied that they are duly qualified in other respects. Should any selected candidate become disqualified, the Government of India will determine whether the vacancy thus created shall be filled or not ; in the former case where the vacancy occurs on account of the disqualification of a candidate selected for appointment in order of merit the candidate next in order of merit, and in other respects duly qualified, shall be deemed to be the selected candidate.

NOTE.—The examination will be a combined examination for the purpose of filling vacancies in the Indian Service of Engineers, the Indian Railway Service of Engineers and the Superior Telegraph Engineering and Wireless Branches of the Indian Posts and Telegraphs Department. A candidate may apply to be admitted as a candidate for all or any of these posts. If he wishes to be admitted as a candidate for more than one service or branch he should state this on his application form. In that case he need send in only one application form and undergo one examination by a Medical Board. He will be required to pay the fees mentioned in Rule 12 once only and will not be required to pay a separate fee for each service or branch for which he applies. If he proves successful as a candidate for more than one service or branch he will ordinarily be assigned to that service or branch for which he expressed a preference at the time of his application, provided that the vacancies have not already been filled, but the Government of India reserve power to assign him to any service or branch for which he is a candidate if in their opinion the exigencies of the public service render this desirable. Candidates who are also candidates for a service or branch not included in these regulations should refer to the regulations specially applicable to that service or branch.

The maximum number of candidates to be admitted to the combined examination may in the discretion of the Governor General in Council be limited to such number not being less than 200 as the Governor General in Council may decide. If a limit is imposed the Public Service Commission shall select from among the applicants those who shall be admitted to the examination.

4. (1) A candidate shall apply to be admitted to the examination before such date and in such form as the Governor General in Council may direct. The application shall be made to the authority of the area in which his parents reside at the time of his application or have previously resided for a period of not less than 3 years or in which he has himself resided, otherwise than as a student at a University only, for a like period.

(2) The application shall be made, if based on residence in a Governor's province, to the Chief Secretary of that province, if based on residence in Coorg, the North-West Frontier Province, Delhi, Ajmer-Merwara, or British Baluchistan, to the Chief Commissioner concerned and if based on residence in a State in India to the Political Officer or Agent through the Darbar.

(3) No candidate shall make more than one application in respect of any one examination.

5. A candidate must be male who is either (*i*) a British subject of Indian domicile, who was, and whose father and mother were, born within His Majesty's dominions and allegiance, or (*ii*) a British subject of Indian domicile whose father was at the time of the candidate's birth and still is (or if dead, continued until his death to be) a British subject or a subject of a State in India, or (*iii*) a ruler or a subject of a State in India in respect of whom the Governor General in Council has made a declaration under Section 96-A of the Government of India Act.

6. A candidate must have attained the age of 21 and must not have attained the age of 25 on the 1st day of August* next preceding the date of the examination.

7. A candidate must be in good mental and bodily health and free from any physical defect likely to interfere with the efficient performance of his duties and a candidate who is found after examination by a Medical Board not to satisfy these requirements will not be accepted for admission to the examination.

8. A candidate must satisfy the Public Service Commission that his character is such as to qualify him for employment in the Indian Posts and Telegraphs Department.

9. A candidate must—

(*i*) hold the Engineering Certificate of the Thomason Civil Engineering College, Roorkee ; or

(*ii*) have passed parts A and B of the Associate Membership examination of the Institution of Engineers (India) ; or

(*iii*) have passed one of the Indian examinations mentioned in Appendix II;

(*iv*) have obtained an Engineering degree of one of the Universities mentioned in Appendix III under the conditions prescribed in that Appendix ; or

(*v*) have passed Sections A and B of the Associate Membership examination of the Institution of Civil Engineers ; or

(*vi*) have passed the Associateship examination of the City and Guilds Institute (Imperial College of Science and Technology, South Kensington) in Civil Engineering ; or

(*vii*) have passed the Associate Membership examination of the Institution of Mechanical Engineers or graduateship examination of the Institution of Electrical Engineers ; or

(*viii*) have passed the Associate examination of the Bengal Engineering College in Mechanical Engineering ; or

(*ix*) have obtained such other diploma or distinction in Engineering as the Governor General in Council on the advice of the Public Service Commission may decide to accept.

10. No candidate shall be admitted to the examination unless he holds a certificate given by the Public Service Commission of having been accepted for admission.

11. No recommendations except those invited in the form of application will be taken into consideration. Any attempt on the part of a candidate to obtain support for his application by other means may disqualify him for selection.

12. Candidates must pay the following fees :—

(*i*) Rs. 5 with the application form ;

(*ii*) Rs. 16 before examination by a Medical Board ; and

(*iii*) if accepted for admission to the examination, Rs. 75 within three weeks after the notification of acceptance.

No claims for a refund of these fees will be entertained.†

13. The examination will include the following subjects each of which will carry the number of marks shown against it :—

(*a*) *Compulsory*—

	Marks.
(1) English (including Essay and Précis Writing)	100
(2) General Knowledge.. ..	200
(3) Applied Mathematics ..	100
(4) Applied Mechanics (including Strength of Materials and Theory of Structures) ..	100
(5) Electrical Engineering ..	100
(6) Viva Voce	200

(*b*) *Optional*—

Not more than one of the following subjects :—

	Marks.
(1) Physics (including Electricity and Magnetism) ..	100
(2) Prime Movers	100
(3) Hydraulics and Hydraulic machines	100
(4) Construction	100
(*i*) Building materials.	
(*ii*) Design of structures.	
(*iii*) General principles governing the design of railways, roads, harbours and other works.	
(5) Surveying	100
(6) Sanitary Engineering and Water Supply	100

14. The standard and syllabus of the examinations shall be such as the Public Service Commission shall prescribe and the Commission shall, if they think it desirable, determine what shall be the qualifying marks in all or any of the subjects of examination.

15. From the marks assigned to candidates in each subject such deduction will be made as the Public Service Commission may consider necessary in order to secure that no credit is allowed for merely superficial knowledge.

16. If a candidate's handwriting is not easily legible, a deduction will be made on this account from the total marks otherwise accruing to him.

17. Credit will be given for good English including orderly, effective and exact expression combined with due economy of words in all subjects of the examination and not only in subjects which are specially devoted to English.

18. A list of the competitors shall be made out in order of merit as disclosed by the aggregate marks finally awarded to each competitor.

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* Note.—These age limits apply whether or not the candidate is already in Government service.

† *See* Note to Rule 3.

APPENDIX I.

General Conditions of Service prescribed for Probationers in the Superior Telegraph Engineering and Wireless Branches of the Indian Posts and Telegraphs Department.

1. *Apprenticeship.*—Selected candidates will be appointed as apprentices for training in the Department for one year during which period they will receive a subsistence allowance of Rs. 200 a month. Those who pass the year of apprenticeship satisfactorily will be appointed on probation for one year as Assistant Divisional Engineers. Their confirmation at the end of that year will depend on the result of that probation and on their passing certain prescribed departmental tests.

2. *Provident Fund.*—Officers entering the Superior Telegraph Engineering and Wireless Branches will be eligible to join the General Provident Fund and will be governed by the rules regulating that Fund.

APPENDIX II.

List of Examinations.

Final examinations leading up to the following degrees:—

B.E. of Bombay University.

B.E. of Calcutta University (College of Engineering, Sibpur).

B.E. of Madras University.

B.Sc. (Engineering) of Benares Hindu University.

The examination for the certificate in Electrical Technology of the Indian Institute of Science, Bangalore.

APPENDIX III.

List of University degrees which will be recognised for admission to the examination.

Oxford.—B.A., with Honours in the Engineering Science Final Honours School.

Cambridge.—B.A., with Honours in Mechanical Science Tripos, or Ordinary degree (B.A.) in Engineering, provided the graduate has passed in the principal subjects, Engineering I, Engineering II, and Engineering III.

St. Andrews.—B.Sc. in Engineering (Honours or Ordinary degree).

Glasgow.—B.Sc. in Civil or Mechanical or Electrical Engineering, or in Naval Architecture (Honours or Ordinary degree).

Edinburgh.—B.Sc. in Engineering (Honours or Ordinary degree).

Dublin.—B.A.I. (Ordinary or with Honours in Engineering).

Durham.—B.Sc. in Civil, or Mechanical, or Electrical, or Marine Engineering, or in Naval Architecture (Honours or Ordinary degree).

London.—B.Sc. (Internal degree) in Engineering, Ordinary or with Honours [not including the B.Sc. in Engineering (Mining) or the B. Sc. in Engineering (Metallurgy)]. The External degree is also accepted to the same extent provided it is recognised by the Institution of Civil Engineers as exempting from Sections A and B of the A.M.I.C.E. examination.

Victoria University (Manchester).—B.Sc. in Engineering (Honours degree or Ordinary degree obtained in and after 1920). B.Sc. Tech. in Mechanical or Electrical Engineering (Higher Course degree or Ordinary Course degree with a First Division pass in the final examination).

Birmingham.—B.Sc. in Civil, Mechanical, or Electrical Engineering (Honours or Ordinary degree).

Liverpool.—B. Eng. in Civil, Mechanical, Electrical or Marine Engineering, or Naval Architecture (Honours or Ordinary degree).

Leeds.—B.Sc. in Civil, Mechanical or Electrical Engineering (Honours or Ordinary degree).

Sheffield.—B.Eng. in Civil, Mechanical or Electrical Engineering (Honours degree or Ordinary degree with a First Class in the final examination). A First Class in the final examination will not be required in the cases of degrees obtained in or after June 1930.

Bristol.—B.Sc. in Civil or Mechanical or Electrical Engineering (Honours or Ordinary degree).

University of Wales.—B.Sc. in Civil, Mechanical or Electrical Engineering.

National University of Ireland.—B.E.

Queen's University, Belfast.—B.Sc. in Engineering.

Aberdeen.—B.Sc. in Engineering (Honours or Ordinary degree).

NOTE.—The above degrees will be accepted only if taken after three years' study and the passing of the regular examinations in the several Universities. The conditions as to three years' study will not, however, apply to Indians who, having taken an Indian degree, which exempts them from part of the University course, shall have taken one of the above degrees in less than three years in accordance with the regulations of the University concerned.

M Telegraph—140—9-9-30—GIPS

Syllabus of the Examination for the Indian Service of Engineers, the Indian Railway Service of Engineers and the Superior Telegraph and Wireless Engineering Branches of the Posts and Telegraphs Department in the compulsory and optional subjects.

Note.—There will be no practical examination in any of the subjects.

Applied Mathematics.

Statics.—Vectors. Notion of force. Gravitational or Engineer's unit of force. Various kinds of forces. Friction. Composition and resolution of concurrent forces. Moments. Parallel forces and centres of gravity. Couples. Conditions of equilibrium of non-current coplanar forces. Funicular polygon.

Kinematics.—Units of space and time. Rectilinear motion; motion of a projectile; angular motion; relative motion; simple harmonic motion.

Kinetics.—Newton's Laws. Absolute system of units. Linear momentum. Impact of elastic bodies. Impulse and impulsive forces. Angular momentum; moments of inertia and radii of gyration; impulsive torque. Centrifugal forces. Conical pendulum. Motion of the centre of mass. Cant on railway curves and banking of road-tracks. Hoop stress and stress in the rim of a fly-wheel.

Work, power, kinetic and potential energy. Principle of energy. Kinetic energy due to rotation. Work done by a couple. Principle of Virtual work. Simple machines, mechanical advantage, and velocity ratio. Stable and unstable equilibrium. Deflection in a framed structure. Oscillations. Simple and Compound pendulum. Units and dimensions.

Hydrostatics.—Fluid pressure, its transmission, and measurement; density; specific gravity; metric system of units; resultant pressure; centre of pressure; equilibrium of floating bodies; metacentre. Laws of Boyle and Charles. Mixture of gasses. Nature and action of simple hydraulic machines.

Applied Mechanics.

(*a*) *Buildings.*

Consideration of materials used in the construction of roof-trusses. Steel and timber. Determination of stresses in trusses by various methods. Dead-loads and wind pressures. Factors of safety and working stresses.

Design of roof-trusses. Various types of roof-trusses and roof coverings; collar beam and hammer beam trusses.

Use of Euler's, Gordon's, Rankine's, Fidler's, Johnson's and straight line formulæ in the design of struts. Buckling factor of struts; curves showing comparative strength of struts obtained by various formulæ. Choice of size of sections. Finish of steel work. Joints. Design of end-bearings; methods of fixing and supporting ends.

Application of circle and ellipse of stress and Clapeyron's theorem to design of structures.

Cast Iron and Steel Columns.—Flange and web connections to steel columns; caps; bases; transverse bracing of columns.

Foundations.—Safe pressures; foundations for columns. Slab foundations; cantilever foundations; grillage foundations. Wells. Piles.

Retaining Walls and Earth-pressures.—Rankine's theory, Wedge theory, Winkler's and Bligh's graphical constructions, with corrections. Design of various types of retaining walls in masonry.

Tall Masonry and Steel Chimneys.—Theory and design.

Design of steel and masonry reservoirs; with considerations of wind-pressures.

Deflection of framed structures and determination of stresses, etc., in redundant frames.

Influence diagrams for bending moment and shear for uniformly distributed and irregular loads on trusses, built-in beams, and three-pinned, parabolic, semi-elliptic and semi-circular arches.

General principles of dome design.

Principles of Building Design; consideration of loads on buildings. Steel-work, girders, etc., for buildings.

(*b*) *Bridges.*

Design of superstructure. Determination by graphical and analytical methods of bending moment due to moving loads. Wind-pressures.

Design of masonry bridges and culverts.

Plate-web girders. Analysis of stresses.

Warren and lattice girders.

Three-pinned arches; doubly pinned and rigid arches.

General considerations on the design of suspension, cantilever, and tubular bridges.

Steel-arched bridges.

Swing bridges.

(*c*) *Reinforced Concrete.*

Shear, bond, and diagonal tension, its nature, evaluation and location of reinforcement.

Design of simple and doubly reinforced beams, and continuous beams.

Theory and design of reinforced concrete columns and piles.

Design of slab foundations.

Design of simple cantilever and counterfort retaining walls.

Equivalent moments of inertia for reinforced concrete sections.

Theory of elastic deflections and outline of investigation of stresses in reinforced concrete arches.

(*d*) *General.*

Analysis of stress, analysis of strain, elastic limit and ultimate strength. Relation between

the elastic constants. Launhardt-Weyrauch formula for working stresses in a structural member and determination of its cross-sectional area. Repetition of stresses. Bending moment and shearing force diagrams for dead loads. Graphical determination of stresses in frames; effect of wind pressure; method of sections. Stress in the cross-section of a beam due to bending (M/I-f/y-E/R); compound and conjugated stresses. Rankine's theory of earth-pressure; depth of foundations and strength of footings. Grillage foundations; Coulomb's theory of earth-pressure; modification due to Rebahn.

Bending moment and shearing force diagrams for live loads. Analysis of uniform and uniformly varying stress. Elastic theory of bending of beams; bending and shear stresses in beams. Modulus of section and equivalent areas. Maximum and minimum stresses in a joint due to eccentric loading. Stresses in dams and chimneys. Stability of block-work structures. Design of rivetted joints and stresses in boiler shells. Euler's theory concerning struts; modifications due to Rankine, Gordon and others. Torsion. Combind torsion and bending deflections. Encastre beams. Continuous beams and theorem of three moments. Elastic theory of arches. Masonry arches.

Physics (including Electricity and Magnetism).

Heat.—The methods of calorimetry and thermometry. Vapour-pressures, critical temperature and pressure. Conduction and diffusion of heat and the determination of constants. Radiation and absorption; laws of cooling. Theory of exchanges; methods of measuring radiation. Laws of thermodynamics; simple applications.

Light.—Velocity of light. Illumination; photometry. Achromatism in lens systems; direct-vision spectroscope.

The wave theory; simple interference phenomena. Huygens' principle explanation of straight line propagation, reflexion, and refraction of light. Action of mirrors, lenses, etc., reviewed from this standpoint. Simple diffraction phenomena. Gratings and wave-length determination. Spectrum analysis; Doppler's principle. Double refraction and polarization of light; rotatory polarization; simple applications.

Magnetism.—Forces on a magnet in a magnetic field. Determination of axes and moment of magnet. Magnetic potential, level surfaces. Interaction of two short magnets; determination of filed strength. Magnetic shell; its potential energy in magnetic field. Total normal induction Gauss' theorem; number of lines of force. Magnetic induction in iron, etc. Theory of magnetism.

The magnetic field of the earth; the elements and their variations; the compass and its corrections.

Electricity.—Electric capacity; specific inductive capacity. Distribution of electricity on surface of conductors; images. Value of electric force in simple cases of distribution. The mechanical force on charged conductors; energy of electrified systems. The dielectric medium; dielectric displacement currents.

Wheatstone's bridge; specific resistance; resistance thermometers. Conductivity of electrolytes; ionization; migration phenomena; accumulators. Standard cells; the potentiometer system of measurement. Thermo-electricity; application of thermo-dynamics; thermo-electric diagrams. Electro-magnetic induction; coefficients of induction; induction coils. Energy of circuit carrying current when placed in a magnetic field; mechanical force on conductors carrying current; moving coil instruments. Lenz's law; illustration from dynamos and motors, etc. Determination of current resistance; E. M. F. in absolute measure. The discharge of a condenser; electric waves. Elementary theory of the electron.

The elementary theory of the continuous current dynamo and motor, and of the alternating current dynamo. General Principles of the application of electricity to lighting power-transmission, telegraphy, etc.

Sound.—The transmission of energy through material media by wave-motion; speed of propagation of waves of permanent type. Nature of musical sounds; pitch; scales. Reflection and refraction of sound; influence of wave-length. The vibration of strings, bars, plates and gas columns; resonance. Interference and diffraction phenomena. Analysis of sound. Measurement of wave-length, velocity and pitch.

Prime Movers.

Fuel, Gas Plants and Boilers—

Fuel. (*a*)—Coal, wood, petroleum, gas, petrol, alcohol, etc.; physical characteristics; approximate chemical composition; heat of combustion.

(*b*) *Gas Plants.*—Gas-Producers; pressure and suction plants; arrangement and working.

(*c*) *Boilers.*—Draught; natural, forced and induced. Ordinary forms of stationary, locomotive, marine, water-tube, and other types; heating surface, fire-grate area; boiler efficiency; superheaters; feedwater heaters; accessories and management.

Theory of Heat Engines—

(*a*) Thermodynamical principles; Carnot's cycle; perfect heat engine; second law.

(*b*) *Air Engines.*—Stirling and other forms.

(*c*) *Internal Combustion Engines.*—Gas, oil and petrol engines; engines with fluid pistons; types and working; features of cycles. Proportioning of mixtures; efficiencies.

(*d*) *Steam.*—Thermodynamics of the generation, expansion, and condensation of steam; heat diagrams, etc.

(*e*) Steam Engines and turbines, with special reference to modern developments.

(*f*) *Refrigerating Plant.*—Theory and general arrangement of the more common types.

(*g*) *Air Compressors.*—Theory of pneumatic working.

Generating Plants, Accessories and Details—

(*a*) General arrangements and construction of the more important types.

(*b*) Condensers, air-pumps, circulating pumps, cooling tanks, etc.

(*c*) Carburettors, and systems of ignition.

(*d*) Cylinders, pistons, crossheads, guides, connecting rods, cranks, governors, fly-wheels, valves and valve gears, glands and pipes.

(*e*) *Engine-Testing.*—Consumption of steam and fuel, gas and oil; brakes and dynamometers; indicators, and indicator diagrams.

Hydraulics and Hydraulic Machines.

Hydraulics.—Definitions relating to flow of water; stream-line motion Bernoulli's theorem Venturimeter.

Flow of water through small and large orifices; drowned orifices; sudden enlargements and contractions in flow of water. Time of emptying tanks. Flood absorptive capacity of tanks.

Flow of water over notches and weirs.

Flow of water through pipes; hydraulic gradients; losses of head due to bends, contractions and sudden enlargements; losses of head through siphons. Impacts at bends and thrust-blocks.

Flow of water in open channels and in pipes; Chezy, Basin, Kutters, and other formulæ and their applications; cross sections of greatest efficiency.

Calculations of afflux and back water curve.

Gauging the flow of water in open channels; water-meters.

Hydraulics and hydrostatics of weirs and other canal works.

Hydrokinetics; uniform and steady flow; stream-line and turbulent motion. Bernoulli's theorem and its application.

Discharge through orifices and mouth pieces, and over notches and weirs. Variable heads. Laws of fluid friction. Head lost due to friction.

Hydraulic Machinery.—Impact of water on fixed and moving vanes. Turbines; impulse and reaction. Description of different types of turbines. Determination of vane-angles. Efficiencies of turbine plant. Governing.

Pumps.—Reciprocating, centrifugal and turbine.

Construction.

(*i*) *Building Materials.*

Stone.—Selection. Characteristics. Indian and European stones. Quarrying. Blasting. Dressing stone. Implements.

Bricks and Tiles.—Classes of bricks and their distinguishing qualities. Moulding. Drying and stacking. Brick-burning. Types of Kiln. Fire-bricks. Terra-cotta. Tile manufacture.

Cements, Limes and Mortars.—Use of mortar. Natural and artificial cements. Varieties of limes. Hydraulicity. Burning. Clamps, Kilns. Plaster. White-wash. Distemper. Concrete. Portland cement.

Timber.—Growth of trees. Felling trees. Classification and properties of Indian and other woods. Most suitable woods for particular purposes.

Stone Masonry.—Ashlar of various sorts. Block-in-course. Bond. Dressing stone. Rubble masonry. Safe loads. Lewis. Dowel. Joggle. Cramp. Template. Scaffolding. Shears. Derrick. Gyn. Gantry.

Brick Masonry.—Types and their uses. Bond. Closers. Bedding. Moisture Scaffolding. Precautions against settlement. Racking back. Plastering. Pointing. Coping. Cornice. Blocking course. Parapet. Eaves course. Corbel. Lintel. Jamb. Reveal. Sill. Footing. Drip-course. Pisé walling. Dhajji walling. Hollow masonry. Reinforced brick-work.

(*ii*) *Design of Structures.*

Buildings.—Design of a residential bungalow; with special reference to selection of site, construction of walls, damp-proof courses, water-supply, drainage and ventilation.

Fire-proof construction.

Reinforced brick-work design; beams, floors, etc.

Thomson's principles of similar structures as regards their strength, stability, deflections, etc.

Bridges.—Selection of site. Determination of discharge of river by consideration of area of watershed, intensity of rainfall, and by zoning. Waterway to be provided. Depth of scour.

Design of foundation. Box; crate; well; pile; continuous masonry; reinforced concrete slab. Piers, ordinary and abutment. Floors and curtain walls.

Reinforced Concrete.—Nature, uses, properties, advantages and disadvantages of Reinforced Concrete over other types of construction. Assumption made in theory of stress in reinforced concrete beams.

Theory and design of simple beams, T-beams and slabs for different conditions of loading.

(*iii*) *General Principles governing the design of Railways, Roads, Harbours and other works.*

Roads.—Formation and permanent way. Types of roadways. Hill roads. Ruling gradients. Resistance of vehicles. Drainage. Tramways.

Railways.—Formation and permanent way. Gauges. Tractive force. Tunnelling. Light railways and mountain railways.

River Training Works.—Spurs. Groynes. Bell Bunds. Streamlime Bunds. Mattresses. Aprons.

Miscellaneous.—Piles and pile-driving; sheet and screw piling. Diving operations, reclamations and dredging. Retaining walls. Depth of foundations. Counterforts and buttresses. Revetments. Construction and sinking of masonry wells. Simple masonry dams. Technical names of various parts.

Surveying.

Surveying.—Construction of Scales. Conventional signs. Use and adjustment of instruments. Theory of levelling; simple, compound, check and reciprocal levelling. Various causes of errors in levelling. Elimination of such errors. Customary limits for errors. Method of keeping various styles of field-books. Use of boning rods. Chain survey. Chain and compass survey.

Theodolite Traversing by Gale's traverse system for city and town improvement surveys. Source of errors and required precision in traversing. Traverse tables. Theory and use of the simple plane-table and tangent clinometer, with and without the magnetic compass. Theory and use of the stadia method of plane-tabling with levelled heights and reductions of distances and heights by slide-rule. The three point problem or plane-tabling by resection from within and without the triangle. Geometrical and trigonometrical proof of the three point problem. The two point problem with and without the magnetic compass. Triangulation with reciprocal value; heights of stations; base line measurements. Finding values of position by observations to three known points. Computation by rectangular co-ordinates with convergency correction.

Contouring of the triangulated area by heights calculated from the reduced levels. Longitudinal and cross-sections run with a level. The location on the map of a road, railway, canal or weir, etc. The general principles of tunnel alignment and of carrying surface meridians underground for mine-surveys. Discussion on the latest patterns of instruments.

Practical Astronomy.—Introduction to spherical trigonometry up to the solution of the spherical triangle, and the adaptation of Napier's rules of circular parts. Definitions; systems of celestial co-ordinates; the reasons for sidereal, sun and mean time; acceleration, retardation and equation of time. The Julian and Gregorian calendars; time and the various astronomical corrections.

Finding the meridian of a place by observations to the sun or a star at upper culmination, by equal altitudes, by the sun or stars not on the meridian, and by circumpolar stars at elongation; and finding time by the sun or stars on the meridian and ex-meridian; finding latitude by Polaris and circum-meridional observations. Use and construction of sundials.

Railway Curves and Alignments.—Theory of curves. Curves laid out with the aid of angular instruments; with one theodolite. Curves laid out by linear measurement only. By chords and offsets (several methods). By offsets inside the curve. Curve by ordinates from the long chord. Curve with certain given data to pass through a ruling point. Compound curves. Diversion curve. Vertical curves. Curve spiral or transition curve. Double centre method for laying out a straight line. Setting out pegs for earth work. Computation of areas of cross sections, etc.

Sanitary Engineering and Water Supply.

Water Supply. Source of Supply.—Springs; wells; rivers; lakes; choosing the supply.

Waterworks.—Intakes; settling tanks; filters; rates of filtration; various types of mechanical filtration.

Reservoirs.—Impounding, storage and service reservoirs; water-towers.

Pipes.—Rising mains; expansion joints; losses in head; valves; service-tanks; house-connections; meters; cisterns.

Pumping Installations.—General types of installations used in India.

Sanitary Engineering.—Water purification; natural waters, impurities present; methods employed for rendering natural waters potable; boiler-waters and softening agents; interpretation of analytical reports.

Sanitary laws; refuse removal and disposal; the chemistry of sewage; river-pollution and its effects; sewerage systems; sewers, their construction and ventilation; traps; house drainage; purification of sewage; chemical precipitation and precipitants; liquefaction of sewage; sewage-oxidation; irrigation and trenching; sewage farms; septic tanks; contract beds; the combined system; details concerning tanks, filters and filtration; distributors, etc.

Electrical Engineering.

Electric Units. Commercial electrical measuring instruments for D. C. and A. C., their action and use in D. C. and A. C. circuits.

Dynamo electric Machines. Physical principles and essential parts of both Generators and Motors. Description of the standard form of field. Description of armature, lamination and its object, lap and wave windings, action of the armature winding and commutator. Arrangements of induced E. M. Fs. in wave and lap windings.

Description of Commutator and Brush Gear. Discussion of sparking at brushes and methods of dealing with it by contact resistance and E. M. Fs. Interpoles Armature reaction.

Description of continuous current dynamos, series, shunt and compound wound. Method of regulating voltage, parallel running, characteristic curves.

Shunt and series motors and their working characteristics, Motor Starters, Losses in a motor and its Rating. Efficiency curves. Suitability of D. C. motor for different types of load.

Alternative current Principles graphical representation of an A. C. frequency, phase and effective value of current and voltage. Use of rotating vectors. Resistance. Inductance and capacity. Power factor. Three-phase circuits and measurement of three-phase power supply. Production of rotatory field. Star and mesh connections.

Description of single and three-phase generators. Synchronising and parallel running.

Description of single and three-phase motors. Induction motors. Squirrel cage and wound motors. Methods of starting.

Transformers. Convertors and Motor-Generators. General description and discussion of their action and construction.

Accumulators. Boosters. Installation and upkeep.

Switchboard and arrangement of measuring, controlling and protective devices for D. C. and A. C. supply.

Mechanism of distribution of electric supply—Busbars. Feeders. Distributors and internal wiring. Requirements to be satisfied by conductors used in distribution as regards voltage regulation, reliability and economy. Value of high tension, three-wire system Balancers. Comparison of D. C. and A. C. Systems of Transmission and Distribution as regards amount of copper required for mains.

Overhead and underground mains. Principal types of cables used. Types of poles and insulators, Lightning arrestors.

Voltage drop in the D. C. and A. C. circuits and Transmission Lines.

Insulation resistance and its measurement, the megger.

Calculation of size of conductors.

Three-phase Transmission and Distribution. Various systems in use.

Transmission lines and arrangements at Power and Sub-Stations.

Internal wiring for power and light. Various systems in use. Testing for insulation resistance and localisation of faults. Wiring rules.

General principles of electric lighting. Lighting of rooms and streets. Description of lamps and fittings in general use.

Electric heating apparatus.

Capital and maintenance costs. Cost of wiring per point. Systems of charging for electric energy.

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Syllabus of the Examination for the Indian Service of Engineers, the Indian Railway Service of Engineers and the Superior Telegraph and Wireless Engineering Branches of the Posts and Telegraphs Department in the compulsory and optional subjects.

Note.—There will be no practical examination in any of the subjects.

Applied Mathematics.

Statics.—Vectors. Notion of force. Gravitational or Engineer's unit of force. Various kinds of forces. Friction. Composition and resolution of concurrent forces. Moments. Parallel forces and centres of gravity. Couples. Conditions of equilibrium of non-current coplanar forces. Funicular polygon.

Kinematics.—Units of space and time. Rectilinear motion; motion of a projectile; angular motion; relative motion; simple harmonic motion.

Kinetics.—Newton's Laws. Absolute system of units. Linear momentum. Impact of elastic bodies. Impulse and impulsive forces. Angular momentum; moments of inertia and radii of gyration; impulsive torque. Centrifugal forces. Conical pendulum. Motion of the centre of mass. Cant on railway curves and banking of road-tracks. Hoop stress and stress in the rim of a fly-wheel.

Work, power, kinetic and potential energy. Principle of energy. Kinetic energy due to rotation. Work done by a couple. Principle of Virtual work. Simple machines, mechanical advantage, and velocity ratio. Stable and unstable equilibrium. Deflection in a framed structure. Oscillations. Simple and Compound pendulum. Units and dimensions.

Hydrostatics.—Fluid pressure, its transmission, and measurement; density; specific gravity; metric system of units; resultant pressure; centre of pressure; equilibrium of floating bodies; metacentre. Laws of Boyle and Charles. Mixture of gasses. Nature and action of simple hydraulic machines.

Applied Mechanics.

(*a*) *Buildings.*

Consideration of materials used in the construction of roof-trusses. Steel and timber. Determination of stresses in trusses by various methods. Dead-loads and wind pressures. Factors of safety and working stresses.

Design of roof-trusses. Various types of roof-trusses and roof coverings; collar beam and hammer beam trusses.

Use of Euler's, Gordon's, Rankine's, Fidler's, Johnson's and straight line formulæ in the design of struts. Buckling factor of struts; curves showing comparative strength of struts obtained by various formulæ. Choice of size of sections. Finish of steel work. Joints. Design of end-bearings; methods of fixing and supporting ends.

Application of circle and ellipse of stress and Clapeyron's theorem to design of structures.

Cast Iron and Steel Columns.—Flange and web connections to steel columns; caps; bases; transverse bracing of columns.

Foundations.—Safe pressures; foundations for columns. Slab foundations; cantilever foundations; grillage foundations. Wells. Piles.

Retaining Walls and Earth-pressures.—Rankine's theory, Wedge theory, Winkler's and Bligh's graphical constructions, with corrections. Design of various types of retaining walls in masonry.

Tall Masonry and Steel Chimneys.—Theory and design.

Design of steel and masonry reservoirs; with considerations of wind-pressures.

Deflection of framed structures and determination of stresses, etc., in redundant frames.

Influence diagrams for bending moment and shear for uniformly distributed and irregular loads on trusses, built-in beams, and three-pinned, parabolic, semi-elliptic and semi-circular arches.

General principles of dome design.

Principles of Building Design; consideration of loads on buildings. Steel-work, girders, etc., for buildings.

(*b*) *Bridges.*

Design of superstructure. Determination by graphical and analytical methods of bending moment due to moving loads. Wind-pressures.

Design of masonry bridges and culverts.

Plate-web girders. Analysis of stresses.

Warren and lattice girders.

Three-pinned arches; doubly pinned and rigid arches.

General considerations on the design of suspension, cantilever, and tubular bridges.

Steel-arched bridges.

Swing bridges.

(*c*) *Reinforced Concrete.*

Shear, bond, and diagonal tension, its nature, evaluation and location of reinforcement.

Design of simple and doubly reinforced beams, and continuous beams.

Theory and design of reinforced concrete columns and piles.

Design of slab foundations.

Design of simple cantilever and counterfort retaining walls.

Equivalent moments of inertia for reinforced concrete sections.

Theory of elastic deflections and outline of investigation of stresses in reinforced concrete arches.

(*d*) *General.*

Analysis of stress, analysis of strain, elastic limit and ultimate strength. Relation between

the elastic constants. Launhardt-Weyrauch formula for working stresses in a structural member and determination of its cross-sectional area. Repetition of stresses. Bending moment and shearing force diagrams for dead loads. Graphical determination of stresses in frames; effect of wind pressure; method of sections. Stress in the cross-section of a beam due to bending (M/I-f/y-E/R); compound and conjugated stresses. Rankine's theory of earth-pressure; depth of foundations and strength of footings. Grillage foundations; Coulomb's theory of earth-pressure; modification due to Rebahn.

Bending moment and shearing force diagrams for live loads. Analysis of uniform and uniformly varying stress. Elastic theory of bending of beams; bending and shear stresses in beams. Modulus of section and equivalent areas. Maximum and minimum stresses in a joint due to eccentric loading. Stresses in dams and chimneys. Stability of block-work structures. Design of rivetted joints and stresses in boiler shells. Euler's theory concerning struts; modifications due to Rankine, Gordon and others. Torsion. Combind torsion and bending deflections. Encastre beams. Continuous beams and theorem of three moments. Elastic theory of arches. Masonry arches.

Physics (including Electricity and Magnetism).

Heat.—The methods of calorimetry and thermometry. Vapour-pressures, critical temperature and pressure. Conduction and diffusion of heat and the determination of constants. Radiation and absorption; laws of cooling. Theory of exchanges; methods of measuring radiation. Laws of thermodynamics; simple applications.

Light.—Velocity of light. Illumination; photometry. Achromatism in lens systems; direct-vision spectroscope.

The wave theory; simple interference phenomena. Huygens' principle explanation of straight line propagation, reflexion, and refraction of light. Action of mirrors, lenses, etc., reviewed from this standpoint. Simple diffraction phenomena. Gratings and wave-length determination. Spectrum analysis; Doppler's principle. Double refraction and polarization of light; rotatory polarization; simple applications.

Magnetism.—Forces on a magnet in a magnetic field. Determination of axes and moment of magnet. Magnetic potential, level surfaces. Interaction of two short magnets; determination of filed strength. Magnetic shell; its potential energy in magnetic field. Total normal induction Gauss' theorem; number of lines of force. Magnetic induction in iron, etc. Theory of magnetism.

The magnetic field of the earth; the elements and their variations; the compass and its corrections.

Electricity.—Electric capacity; specific inductive capacity. Distribution of electricity on surface of conductors; images. Value of electric force in simple cases of distribution. The mechanical force on charged conductors; energy of electrified systems. The dielectric medium; dielectric displacement currents.

Wheatstone's bridge; specific resistance; resistance thermometers. Conductivity of electrolytes; ionization; migration phenomena; accumulators. Standard cells; the potentiometer system of measurement. Thermo-electricity; application of thermo-dynamics; thermo-electric diagrams. Electro-magnetic induction; coefficients of induction; induction coils. Energy of circuit carrying current when placed in a magnetic field; mechanical force on conductors carrying current; moving coil instruments. Lenz's law; illustration from dynamos and motors, etc. Determination of current resistance; E. M. F. in absolute measure. The discharge of a condenser; electric waves. Elementary theory of the electron.

The elementary theory of the continuous current dynamo and motor, and of the alternating current dynamo. General Principles of the application of electricity to lighting power-transmission, telegraphy, etc.

Sound.—The transmission of energy through material media by wave-motion; speed of propagation of waves of permanent type. Nature of musical sounds; pitch; scales. Reflection and refraction of sound; influence of wave-length. The vibration of strings, bars, plates and gas columns; resonance. Interference and diffraction phenomena. Analysis of sound. Measurement of wave-length, velocity and pitch.

Prime Movers.

Fuel, Gas Plants and Boilers—

Fuel. (*a*)—Coal, wood, petroleum, gas, petrol, alcohol, etc.; physical characteristics; approximate chemical composition; heat of combustion.

(*b*) *Gas Plants.*—Gas-Producers; pressure and suction plants; arrangement and working.

(*c*) *Boilers.*—Draught; natural, forced and induced. Ordinary forms of stationary, locomotive, marine, water-tube, and other types; heating surface, fire-grate area; boiler efficiency; superheaters; feedwater heaters; accessories and management.

Theory of Heat Engines—

(*a*) Thermodynamical principles; Carnot's cycle; perfect heat engine; second law.

(*b*) *Air Engines.*—Stirling and other forms.

(*c*) *Internal Combustion Engines.*—Gas, oil and petrol engines; engines with fluid pistons; types and working; features of cycles. Proportioning of mixtures; efficiencies.

(*d*) *Steam.*—Thermodynamics of the generation, expansion, and condensation of steam; heat diagrams, etc.

(*e*) Steam Engines and turbines, with special reference to modern developments.

(*f*) *Refrigerating Plant.*—Theory and general arrangement of the more common types.

(*g*) *Air Compressors.*—Theory of pneumatic working.

Generating Plants, Accessories and Details—

(*a*) General arrangements and construction of the more important types.

(*b*) Condensers, air-pumps, circulating pumps, cooling tanks, etc.

(*c*) Carburettors, and systems of ignition.

(*d*) Cylinders, pistons, crossheads, guides, connecting rods, cranks, governors, fly-wheels, valves and valve gears, glands and pipes.

(*e*) *Engine-Testing.*—Consumption of steam and fuel, gas and oil; brakes and dynamometers; indicators, and indicator diagrams.

Hydraulics and Hydraulic Machines.

Hydraulics.—Definitions relating to flow of water; stream-line motion Bernoulli's theorem Venturimeter.

Flow of water through small and large orifices; drowned orifices; sudden enlargements and contractions in flow of water. Time of emptying tanks. Flood absorptive capacity of tanks.

Flow of water over notches and weirs.

Flow of water through pipes; hydraulic gradients; losses of head due to bends, contractions and sudden enlargements; losses of head through siphons. Impacts at bends and thrust-blocks.

Flow of water in open channels and in pipes; Chezy, Basin, Kutters, and other formulæ and their applications; cross sections of greatest efficiency.

Calculations of afflux and back water curve.

Gauging the flow of water in open channels; water-meters.

Hydraulics and hydrostatics of weirs and other canal works.

Hydrokinetics; uniform and steady flow; stream-line and turbulent motion. Bernoulli's theorem and its application.

Discharge through orifices and mouth pieces, and over notches and weirs. Variable heads. Laws of fluid friction. Head lost due to friction.

Hydraulic Machinery.—Impact of water on fixed and moving vanes. Turbines; impulse and reaction. Description of different types of turbines. Determination of vane-angles. Efficiencies of turbine plant. Governing.

Pumps.—Reciprocating, centrifugal and turbine.

Construction.

(*i*) *Building Materials.*

Stone.—Selection. Characteristics. Indian and European stones. Quarrying. Blasting. Dressing stone. Implements.

Bricks and Tiles.—Classes of bricks and their distinguishing qualities. Moulding. Drying and stacking. Brick-burning. Types of Kiln. Fire-bricks. Terra-cotta. Tile manufacture.

Cements, Limes and Mortars.—Use of mortar. Natural and artificial cements. Varieties of limes. Hydraulicity. Burning. Clamps, Kilns. Plaster. White-wash. Distemper. Concrete. Portland cement.

Timber.—Growth of trees. Felling trees. Classification and properties of Indian and other woods. Most suitable woods for particular purposes.

Stone Masonry.—Ashlar of various sorts. Block-in-course. Bond. Dressing stone. Rubble masonry. Safe loads. Lewis. Dowel. Joggle. Cramp. Template. Scaffolding. Shears. Derrick. Gyn. Gantry.

Brick Masonry.—Types and their uses. Bond. Closers. Bedding. Moisture Scaffolding. Precautions against settlement. Racking back. Plastering. Pointing. Coping. Cornice. Blocking course. Parapet. Eaves course. Corbel. Lintel. Jamb. Reveal. Sill. Footing. Drip-course. Pisé walling. Dhajji walling. Hollow masonry. Reinforced brick-work.

(*ii*) *Design of Structures.*

Buildings.—Design of a residential bungalow; with special reference to selection of site, construction of walls, damp-proof courses, water-supply, drainage and ventilation.

Fire-proof construction.

Reinforced brick-work design; beams, floors, etc.

Thomson's principles of similar structures as regards their strength, stability, deflections, etc.

Bridges.—Selection of site. Determination of discharge of river by consideration of area of watershed, intensity of rainfall, and by zoning. Waterway to be provided. Depth of scour.

Design of foundation. Box; crate; well; pile; continuous masonry; reinforced concrete slab. Piers, ordinary and abutment. Floors and curtain walls.

Reinforced Concrete.—Nature, uses, properties, advantages and disadvantages of Reinforced Concrete over other types of construction. Assumption made in theory of stress in reinforced concrete beams.

Theory and design of simple beams, T-beams and slabs for different conditions of loading.

(*iii*) *General Principles governing the design of Railways, Roads, Harbours and other works.*

Roads.—Formation and permanent way. Types of roadways. Hill roads. Ruling gradients. Resistance of vehicles. Drainage. Tramways.

Railways.—Formation and permanent way. Gauges. Tractive force. Tunnelling. Light railways and mountain railways.

River Training Works.—Spurs. Groynes. Bell Bunds. Streamlime Bunds. Mattresses. Aprons.

Miscellaneous.—Piles and pile-driving; sheet and screw piling. Diving operations, reclamations and dredging. Retaining walls. Depth of foundations. Counterforts and buttresses. Revetments. Construction and sinking of masonry wells. Simple masonry dams. Technical names of various parts.

Surveying.

Surveying.—Construction of Scales. Conventional signs. Use and adjustment of instruments. Theory of levelling; simple, compound, check and reciprocal levelling. Various causes of errors in levelling. Elimination of such errors. Customary limits for errors. Method of keeping various styles of field-books. Use of boning rods. Chain survey. Chain and compass survey.

Theodolite Traversing by Gale's traverse system for city and town improvement surveys. Source of errors and required precision in traversing. Traverse tables. Theory and use of the simple plane-table and tangent clinometer, with and without the magnetic compass. Theory and use of the stadia method of plane-tabling with levelled heights and reductions of distances and heights by slide-rule. The three point problem or plane-tabling by resection from within and without the triangle. Geometrical and trigonometrical proof of the three point problem. The two point problem with and without the magnetic compass. Triangulation with reciprocal value; heights of stations; base line measurements. Finding values of position by observations to three known points. Computation by rectangular co-ordinates with convergency correction.

Contouring of the triangulated area by heights calculated from the reduced levels. Longitudinal and cross-sections run with a level. The location on the map of a road, railway, canal or weir, etc. The general principles of tunnel alignment and of carrying surface meridians underground for mine-surveys. Discussion on the latest patterns of instruments.

Practical Astronomy.— Introduction to spherical trigonometry up to the solution of the spherical triangle, and the adaptation of Napier's rules of circular parts. Definitions; systems of celestial co-ordinates; the reasons for sidereal, sun and mean time; acceleration, retardation and equation of time. The Julian and Gregorian calendars; time and the various astronomical corrections.

Finding the meridian of a place by observations to the sun or a star at upper culmination, by equal altitudes, by the sun or stars not on the meridian, and by circumpolar stars at elongation; and finding time by the sun or stars on the meridian and ex-meridian; finding latitude by Polaris and circum-meridional observations. Use and construction of sundials.

Railway Curves and Alignments.—Theory of curves. Curves laid out with the aid of angular instruments; with one theodolite. Curves laid out by linear measurement only. By chords and offsets (several methods). By offsets inside the curve. Curve by ordinates from the long chord. Curve with certain given data to pass through a ruling point. Compound curves. Diversion curve. Vertical curves. Curve spiral or transition curve. Double centre method for laying out a straight line. Setting out pegs for earth work. Computation of areas of cross sections, etc.

Sanitary Engineering and Water Supply.

Water Supply. Source of Supply.—Springs; wells; rivers; lakes; choosing the supply.

Waterworks.—Intakes; settling tanks; filters; rates of filtration; various types of mechanical filtration.

Reservoirs.—Impounding, storage and service reservoirs; water-towers.

Pipes.—Rising mains; expansion joints; losses in head; valves; service-tanks; house-connections; meters; cisterns.

Pumping Installations.—General types of installations used in India.

Sanitary Engineering.—Water purification; natural waters, impurities present; methods employed for rendering natural waters potable; boiler-waters and softening agents; interpretation of analytical reports.

Sanitary laws; refuse removal and disposal; the chemistry of sewage; river-pollution and its effects; sewerage systems; sewers, their construction and ventilation; traps; house drainage; purification of sewage; chemical precipitation and precipitants; liquefaction of sewage; sewage-oxidation; irrigation and trenching; sewage farms; septic tanks; contract beds; the combined system; details concerning tanks, filters and filtration; distributors, etc.

Electrical Engineering.

Electric Units. Commercial electrical measuring instruments for D. C. and A. C., their action and use in D. C. and A. C. circuits.

Dynamo electric Machines. Physical principles and essential parts of both Generators and Motors. Description of the standard form of field. Description of armature, lamination and its object, lap and wave windings, action of the armature winding and commutator. Arrangements of induced E. M. Fs. in wave and lap windings.

Description of Commutator and Brush Gear. Discussion of sparking at brushes and methods of dealing with it by contact resistance and E. M. Fs. Interpoles Armature reaction.

Description of continuous current dynamos, series, shunt and compound wound. Method of regulating voltage, parallel running, characteristic curves.

Shunt and series motors and their working characteristics, Motor Starters, Losses in a motor and its Rating. Efficiency curves. Suitability of D. C. motor for different types of load.

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General principles of electric lighting. Lighting of rooms and streets. Description of lamps and fittings in general use.

Electric heating apparatus.

Capital and maintenance costs. Cost of wiring per point. Systems of charging for electric energy.

M51PSC—144—25.9.30—GIPS

RULES FOR THE RECRUITMENT IN INDIA BY EXAMINATION FOR THE SUPERIOR TELEGRAPH ENGINEERING AND WIRELESS BRANCHES OF THE INDIAN POSTS AND TELEGRAPHS DEPARTMENT.

(Reprinted as amended up to August 1930.)

1. A competitive examination for admission to the permanent establishment of the Superior Telegraph Engineering and Wireless Branches of the Indian Posts and Telegraphs Department, shall be held in India at such time and place as the Governor General in Council may direct.

2. Of the total number of vacancies in a year to be filled in India by examination under rule 1, two-thirds will be filled on the results of the competitive examination in the direct order of merit, provided the number of candidates is declared by the Public Service Commission as having qualified by examination. The remaining one-third vacancies will be reserved by the Government of India to redress, so far as may be necessary, marked communal inequalities and any appointments, which it may be necessary to make on these grounds, shall be made by the Governor General in Council, after consultation with the Public Service Commission by direct nomination from among candidates who have attained the qualifying standard at the examination and have satisfied the Public Service Commission that they are in all respects suitable for employment in the Superior Telegraph Engineering and Wireless Branches of the Indian Posts and Telegraphs Department. Such vacancies, among the one-third reserved, as may not be required for the redress of communal inequalities or for which duly qualified candidates for direct nomination may not be forthcoming may be filled in the direct order of merit in which the candidates passed the examination.

3. From the list, prepared by the Public Service Commission, of competitors, who have in the opinion of the Commission attained the qualifying standard, candidates to the number of vacancies to be filled will be selected for appointment in the manner laid down in Rule 2 provided that the Government of India are satisfied that they are duly qualified in other respects. Should any selected candidate become disqualified, the Government of India will determine whether the vacancy thus created shall be filled or not ; in the former case where the vacancy occurs on account of the disqualification of a candidate selected for appointment in order of merit the candidate next in order of merit, and in other respects duly qualified, shall be deemed to be the selected candidate.

NOTE.—The examination will be a combined examination for the purpose of filling vacancies in the Indian Service of Engineers, the Indian Railway Service of Engineers and the Superior Telegraph Engineering and Wireless Branches of the Indian Posts and Telegraphs Department. A candidate may apply to be admitted as a candidate for all or any of these posts. If he wishes to be admitted as a candidate for more than one service or branch he should state this on his application form. In that case he need send in only one application form and undergo one examination by a Medical Board. He will be required to pay the fees mentioned in Rule 12 once only and will not be required to pay a separate fee for each service or branch for which he applies. If he proves successful as a candidate for more than one service or branch he will ordinarily be assigned to that service or branch for which he expressed a preference at the time of his application, provided that the vacancies have not already been filled, but the Government of India reserve power to assign him to any service or branch for which he is a candidate if in their opinion the exigencies of the public service render this desirable. Candidates who are also candidates for a service or branch not included in these regulations should refer to the regulations specially applicable to that service or branch.

The maximum number of candidates to be admitted to the combined examination may in the discretion of the Governor General in Council be limited to such number not being less than 200 as the Governor General in Council may decide. If a limit is imposed the Public Service Commission shall select from among the applicants those who shall be admitted to the examination.

4. (1) A candidate shall apply to be admitted to the examination before such date and in such form as the Governor General in Council may direct. The application shall be made to the authority of the area in which his parents reside at the time of his application or have previously resided for a period of not less than 3 years or in which he has himself resided, otherwise than as a student at a University only, for a like period.

(2) The application shall be made, if based on residence in a Governor's province, to the Chief Secretary of that province, if based on residence in Coorg, the North-West Frontier Province, Delhi, Ajmer-Merwara, or British Baluchistan, to the Chief Commissioner concerned and if based on residence in a State in India to the Political Officer or Agent through the Darbar.

(3) No candidate shall make more than one application in respect of any one examination.

5. A candidate must be male who is either (*i*) a British subject of Indian domicile, who was, and whose father and mother were, born within His Majesty's dominions and allegiance, or (*ii*) a British subject of Indian domicile whose father was at the time of the candidate's birth and still is (or if dead, continued until his death to be) a British subject or a subject of a State in India, or (*iii*) a ruler or a subject of a State in India in respect of whom the Governor General in Council has made a declaration under Section 96-A of the Government of India Act.

6. A candidate must have attained the age of 21 and must not have attained the age of 25 on the 1st day of August* next preceding the date of the examination.

7. A candidate must be in good mental and bodily health and free from any physical defect likely to interfere with the efficient performance of his duties and a candidate who is found after examination by a Medical Board not to satisfy these requirements will not be accepted for admission to the examination.

8. A candidate must satisfy the Public Service Commission that his character is such as to qualify him for employment in the Indian Posts and Telegraphs Department.

9. A candidate must—

(*i*) hold the Engineering Certificate of the Thomason Civil Engineering College, Roorkee ; or

(*ii*) have passed parts A and B of the Associate Membership examination of the Institution of Engineers (India) ; or

(*iii*) have passed one of the Indian examinations mentioned in Appendix II;

(*iv*) have obtained an Engineering degree of one of the Universities mentioned in Appendix III under the conditions prescribed in that Appendix ; or

(*v*) have passed Sections A and B of the Associate Membership examination of the Institution of Civil Engineers ; or

(*vi*) have passed the Associateship examination of the City and Guilds Institute (Imperial College of Science and Technology, South Kensington) in Civil Engineering ; or

(*vii*) have passed the Associate Membership examination of the Institution of Mechanical Engineers or graduateship examination of the Institution of Electrical Engineers ; or

(*viii*) have passed the Associate examination of the Bengal Engineering College in Mechanical Engineering ; or

(*ix*) have obtained such other diploma or distinction in Engineering as the Governor General in Council on the advice of the Public Service Commission may decide to accept.

10. No candidate shall be admitted to the examination unless he holds a certificate given by the Public Service Commission of having been accepted for admission.

11. No recommendations except those invited in the form of application will be taken into consideration. Any attempt on the part of a candidate to obtain support for his application by other means may disqualify him for selection.

12. Candidates must pay the following fees :—

(*i*) Rs. 5 with the application form ;

(*ii*) Rs. 16 before examination by a Medical Board ; and

(*iii*) if accepted for admission to the examination, Rs. 75 within three weeks after the notification of acceptance.

No claims for a refund of these fees will be entertained.†

13. The examination will include the following subjects each of which will carry the number of marks shown against it :—

(*a*) *Compulsory*—

	Marks.
(1) English (including Essay and Précis Writing)	100
(2) General Knowledge.. ..	200
(3) Applied Mathematics ..	100
(4) Applied Mechanics (including Strength of Materials and Theory of Structures) ..	100
(5) Electrical Engineering ..	100
(6) Viva Voce	200

(*b*) *Optional*—

Not more than one of the following subjects :—

	Marks.
(1) Physics (including Electricity and Magnetism) ..	100
(2) Prime Movers	100
(3) Hydraulics and Hydraulic machines	100
(4) Construction	100
(*i*) Building materials.	
(*ii*) Design of structures.	
(*iii*) General principles governing the design of railways, roads, harbours and other works.	
(5) Surveying	100
(6) Sanitary Engineering and Water Supply	100

14. The standard and syllabus of the examinations shall be such as the Public Service Commission shall prescribe and the Commission shall, if they think it desirable, determine what shall be the qualifying marks in all or any of the subjects of examination.

15. From the marks assigned to candidates in each subject such deduction will be made as the Public Service Commission may consider necessary in order to secure that no credit is allowed for merely superficial knowledge.

16. If a candidate's handwriting is not easily legible, a deduction will be made on this account from the total marks otherwise accruing to him.

17. Credit will be given for good English including orderly, effective and exact expression combined with due economy of words in all subjects of the examination and not only in subjects which are specially devoted to English.

18. A list of the competitors shall be made out in order of merit as disclosed by the aggregate marks finally awarded to each competitor.

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* Note.—These age limits apply whether or not the candidate is already in Government service.

† *See* Note to Rule 3.

APPENDIX I.

General Conditions of Service prescribed for Probationers in the Superior Telegraph Engineering and Wireless Branches of the Indian Posts and Telegraphs Department.

1. *Apprenticeship.*—Selected candidates will be appointed as apprentices for training in the Department for one year during which period they will receive a subsistence allowance of Rs. 200 a month. Those who pass the year of apprenticeship satisfactorily will be appointed on probation for one year as Assistant Divisional Engineers. Their confirmation at the end of that year will depend on the result of that probation and on their passing certain prescribed departmental tests.

2. *Provident Fund.*—Officers entering the Superior Telegraph Engineering and Wireless Branches will be eligible to join the General Provident Fund and will be governed by the rules regulating that Fund.

APPENDIX II.

List of Examinations.

Final examinations leading up to the following degrees :—

B.E. of Bombay University.

B.E. of Calcutta University (College of Engineering, Sibpur).

B.E. of Madras University.

B.Sc. (Engineering) of Benares Hindu University.

The examination for the certificate in Electrical Technology of the Indian Institute of Science, Bangalore.

APPENDIX III.

List of University degrees which will be recognised for admission to the examination.

Oxford.—B.A., with Honours in the Engineering Science Final Honours School.

Cambridge.—B.A., with Honours in Mechanical Science Tripos, or Ordinary degree (B.A.) in Engineering, provided the graduate has passed in the principal subjects, Engineering I, Engineering II, and Engineering III.

St. Andrews.—B.Sc. in Engineering (Honours or Ordinary degree).

Glasgow.—B.Sc. in Civil or Mechanical or Electrical Engineering, or in Naval Architecture (Honours or Ordinary degree).

Edinburgh.—B.Sc. in Engineering (Honours or Ordinary degree).

Dublin.—B.A.I. (Ordinary or with Honours in Engineering).

Durham.—B.Sc. in Civil, or Mechanical, or Electrical, or Marine Engineering, or in Naval Architecture (Honours or Ordinary degree).

London.—B.Sc. (Internal degree) in Engineering, Ordinary or with Honours [not including the B.Sc. in Engineering (Mining) or the B. Sc. in Engineering (Metallurgy)]. The External degree is also accepted to the same extent provided it is recognised by the Institution of Civil Engineers as exempting from Sections A and B of the A.M.I.C.E. examination.

Victoria University (Manchester).—B.Sc. in Engineering (Honours degree or Ordinary degree obtained in and after 1920). B.Sc. Tech. in Mechanical or Electrical Engineering (Higher Course degree or Ordinary Course degree with a First Division pass in the final examination).

Birmingham.—B.Sc. in Civil, Mechanical, or Electrical Engineering (Honours or Ordinary degree).

Liverpool.—B. Eng. in Civil, Mechanical, Electrical or Marine Engineering, or Naval Architecture (Honours or Ordinary degree).

Leeds.—B.Sc. in Civil, Mechanical or Electrical Engineering (Honours or Ordinary degree).

Sheffield.—B.Eng. in Civil, Mechanical or Electrical Engineering (Honours degree or Ordinary degree with a First Class in the final examination). A First Class in the final examination will not be required in the cases of degrees obtained in or after June 1930.

Bristol.—B.Sc. in Civil or Mechanical or Electrical Engineering (Honours or Ordinary degree).

University of Wales.—B.Sc. in Civil, Mechanical or Electrical Engineering.

National University of Ireland.—B.E.

Queen's University, Belfast.—B.Sc. in Engineering.

Aberdeen.—B.Sc. in Engineering (Honours or Ordinary degree).

NOTE.—The above degrees will be accepted only if taken after three years' study and the passing of the regular examinations in the several Universities. The conditions as to three years' study will not, however, apply to Indians who, having taken an Indian degree, which exempts them from part of the University course, shall have taken one of the above degrees in less than three years in accordance with the regulations of the University concerned.

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Syllabus of the Examination for the Indian Service of Engineers, the Indian Railway Service of Engineers and the Superior Telegraph and Wireless Engineering Branches of the Posts and Telegraphs Department in the compulsory and optional subjects.

Note.—There will be no practical examination in any of the subjects.

Applied Mathematics.

Statics.—Vectors. Notion of force. Gravitational or Engineer's unit of force. Various kinds of forces. Friction. Composition and resolution of concurrent forces. Moments. Parallel forces and centres of gravity. Couples. Conditions of equilibrium of non-current coplanar forces. Funicular polygon.

Kinematics.—Units of space and time. Rectilinear motion; motion of a projectile; angular motion; relative motion; simple harmonic motion.

Kinetics.—Newton's Laws. Absolute system of units. Linear momentum. Impact of elastic bodies. Impulse and impulsive forces. Angular momentum; moments of inertia and radii of gyration; impulsive torque. Centrifugal forces. Conical pendulum. Motion of the centre of mass. Cant on railway curves and banking of road-tracks. Hoop stress and stress in the rim of a fly-wheel.

Work, power, kinetic and potential energy. Principle of energy. Kinetic energy due to rotation. Work done by a couple. Principle of Virtual work. Simple machines, mechanical advantage, and velocity ratio. Stable and unstable equilibrium. Deflection in a framed structure. Oscillations. Simple and Compound pendulum. Units and dimensions.

Hydrostatics.—Fluid pressure, its transmission, and measurement; density; specific gravity; metric system of units; resultant pressure; centre of pressure; equilibrium of floating bodies; metacentre. Laws of Boyle and Charles. Mixture of gasses. Nature and action of simple hydraulic machines.

Applied Mechanics.

(*a*) *Buildings.*

Consideration of materials used in the construction of roof-trusses. Steel and timber. Determination of stresses in trusses by various methods. Dead-loads and wind pressures. Factors of safety and working stresses.

Design of roof-trusses. Various types of roof-trusses and roof coverings; collar beam and hammer beam trusses.

Use of Euler's, Gordon's, Rankine's, Fidler's, Johnson's and straight line formulæ in the design of struts. Buckling factor of struts; curves showing comparative strength of struts obtained by various formulæ. Choice of size of sections. Finish of steel work. Joints. Design of end-bearings; methods of fixing and supporting ends.

Application of circle and ellipse of stress and Clapeyron's theorem to design of structures.

Cast Iron and Steel Columns.—Flange and web connections to steel columns; caps; bases; transverse bracing of columns.

Foundations.—Safe pressures; foundations for columns. Slab foundations; cantilever foundations; grillage foundations. Wells. Piles.

Retaining Walls and Earth-pressures.—Rankine's theory, Wedge theory, Winkler's and Bligh's graphical constructions, with corrections. Design of various types of retaining walls in masonry.

Tall Masonry and Steel Chimneys.—Theory and design.

Design of steel and masonry reservoirs; with considerations of wind-pressures.

Deflection of framed structures and determination of stresses, etc., in redundant frames.

Influence diagrams for bending moment and shear for uniformly distributed and irregular loads on trusses, built-in beams, and three-pinned, parabolic, semi-elliptic and semi-circular arches.

General principles of dome design.

Principles of Building Design; consideration of loads on buildings. Steel-work, girders, etc., for buildings.

(*b*) *Bridges.*

Design of superstructure. Determination by graphical and analytical methods of bending moment due to moving loads. Wind-pressures.

Design of masonry bridges and culverts.

Plate-web girders. Analysis of stresses.

Warren and lattice girders.

Three-pinned arches; doubly pinned and rigid arches.

General considerations on the design of suspension, cantilever, and tubular bridges.

Steel-arched bridges.

Swing bridges.

(*c*) *Reinforced Concrete.*

Shear, bond, and diagonal tension, its nature, evaluation and location of reinforcement.

Design of simple and doubly reinforced beams, and continuous beams.

Theory and design of reinforced concrete columns and piles.

Design of slab foundations.

Design of simple cantilever and counterfort retaining walls.

Equivalent moments of inertia for reinforced concrete sections.

Theory of elastic deflections and outline of investigation of stresses in reinforced concrete arches.

(*d*) *General.*

Analysis of stress, analysis of strain, elastic limit and ultimate strength. Relation between

the elastic constants. Launhardt-Weyrauch formula for working stresses in a structural member and determination of its cross-sectional area. Repetition of stresses. Bending moment and shearing force diagrams for dead loads. Graphical determination of stresses in frames; effect of wind pressure; method of sections. Stress in the cross-section of a beam due to bending (M/I-f/y-E/R); compound and conjugated stresses. Rankine's theory of earth-pressure; depth of foundations and strength of footings. Grillage foundations; Coulomb's theory of earth-pressure; modification due to Rebahn.

Bending moment and shearing force diagrams for live loads. Analysis of uniform and uniformly varying stress. Elastic theory of bending of beams; bending and shear stresses in beams. Modulus of section and equivalent areas. Maximum and minimum stresses in a joint due to eccentric loading. Stresses in dams and chimneys. Stability of block-work structures. Design of rivetted joints and stresses in boiler shells. Euler's theory concerning struts; modifications due to Rankine, Gordon and others. Torsion. Combind torsion and bending deflections. Encastre beams. Continuous beams and theorem of three moments. Elastic theory of arches. Masonry arches.

Physics (including Electricity and Magnetism).

Heat.—The methods of calorimetry and thermometry. Vapour-pressures, critical temperature and pressure. Conduction and diffusion of heat and the determination of constants. Radiation and absorption; laws of cooling. Theory of exchanges; methods of measuring radiation. Laws of thermodynamics; simple applications.

Light.—Velocity of light. Illumination; photometry. Achromatism in lens systems; direct-vision spectroscope.

The wave theory; simple interference phenomena. Huygens' principle explanation of straight line propagation, reflexion, and refraction of light. Action of mirrors, lenses, etc., reviewed from this standpoint. Simple diffraction phenomena. Gratings and wave-length determination. Spectrum analysis; Doppler's principle. Double refraction and polarization of light; rotatory polarization; simple applications.

Magnetism.—Forces on a magnet in a magnetic field. Determination of axes and moment of magnet. Magnetic potential, level surfaces. Interaction of two short magnets; determination of filed strength. Magnetic shell; its potential energy in magnetic field. Total normal induction Gauss' theorem; number of lines of force. Magnetic induction in iron, etc. Theory of magnetism.

The magnetic field of the earth; the elements and their variations; the compass and its corrections.

Electricity.—Electric capacity; specific inductive capacity. Distribution of electricity on surface of conductors; images. Value of electric force in simple cases of distribution. The mechanical force on charged conductors; energy of electrified systems. The dielectric medium; dielectric displacement currents.

Wheatstone's bridge; specific resistance; resistance thermometers. Conductivity of electrolytes; ionization; migration phenomena; accumulators. Standard cells; the potentiometer system of measurement. Thermo-electricity; application of thermo-dynamics; thermo-electric diagrams. Electro-magnetic induction; coefficients of induction; induction coils. Energy of circuit carrying current when placed in a magnetic field; mechanical force on conductors carrying current; moving coil instruments. Lenz's law; illustration from dynamos and motors, etc. Determination of current resistance; E. M. F. in absolute measure. The discharge of a condenser; electric waves. Elementary theory of the electron.

The elementary theory of the continuous current dynamo and motor, and of the alternating current dynamo. General Principles of the application of electricity to lighting power-transmission, telegraphy, etc.

Sound.—The transmission of energy through material media by wave-motion; speed of propagation of waves of permanent type. Nature of musical sounds; pitch; scales. Reflection and refraction of sound; influence of wave-length. The vibration of strings, bars, plates and gas columns; resonance. Interference and diffraction phenomena. Analysis of sound. Measurement of wave-length, velocity and pitch.

Prime Movers.

Fuel, Gas Plants and Boilers—

Fuel. (*a*)—Coal, wood, petroleum, gas, petrol, alcohol, etc.; physical characteristics; approximate chemical composition; heat of combustion.

(*b*) *Gas Plants.*—Gas-Producers; pressure and suction plants; arrangement and working.

(*c*) *Boilers.*—Draught; natural, forced and induced. Ordinary forms of stationary, locomotive, marine, water-tube, and other types; heating surface, fire-grate area; boiler efficiency; superheaters; feedwater heaters; accessories and management.

Theory of Heat Engines—

(*a*) Thermodynamical principles; Carnot's cycle; perfect heat engine; second law.

(*b*) *Air Engines.*—Stirling and other forms.

(*c*) *Internal Combustion Engines.*—Gas, oil and petrol engines; engines with fluid pistons; types and working; features of cycles. Proportioning of mixtures; efficiencies.

(*d*) *Steam.*—Thermodynamics of the generation, expansion, and condensation of steam; heat diagrams, etc.

(*e*) Steam Engines and turbines, with special reference to modern developments.

(*f*) *Refrigerating Plant.*—Theory and general arrangement of the more common types.

(*g*) *Air Compressors.*—Theory of pneumatic working.

Generating Plants, Accessories and Details—

(*a*) General arrangements and construction of the more important types.

(*b*) Condensers, air-pumps, circulating pumps, cooling tanks, etc.

(*c*) Carburettors, and systems of ignition.

(*d*) Cylinders, pistons, crossheads, guides, connecting rods, cranks, governors, fly-wheels, valves and valve gears, glands and pipes.

(*e*) *Engine-Testing.*—Consumption of steam and fuel, gas and oil; brakes and dynamometers; indicators, and indicator diagrams.

Hydraulics and Hydraulic Machines.

Hydraulics.—Definitions relating to flow of water; stream-line motion Bernoulli's theorem Venturimeter.

Flow of water through small and large orifices; drowned orifices; sudden enlargements and contractions in flow of water. Time of emptying tanks. Flood absorptive capacity of tanks.

Flow of water over notches and weirs.

Flow of water through pipes; hydraulic gradients; losses of head due to bends, contractions and sudden enlargements; losses of head through siphons. Impacts at bends and thrust-blocks.

Flow of water in open channels and in pipes; Chezy, Basin, Kutters, and other formulæ and their applications; cross sections of greatest efficiency.

Calculations of afflux and back water curve.

Gauging the flow of water in open channels; water-meters.

Hydraulics and hydrostatics of weirs and other canal works.

Hydrokinetics; uniform and steady flow; stream-line and turbulent motion. Bernoulli's theorem and its application.

Discharge through orifices and mouth pieces, and over notches and weirs. Variable heads. Laws of fluid friction. Head lost due to friction.

Hydraulic Machinery.—Impact of water on fixed and moving vanes. Turbines; impulse and reaction. Description of different types of turbines. Determination of vane-angles. Efficiencies of turbine plant. Governing.

Pumps.—Reciprocating, centrifugal and turbine.

Construction.

(*i*) *Building Materials.*

Stone.—Selection. Characteristics. Indian and European stones. Quarrying. Blasting. Dressing stone. Implements.

Bricks and Tiles.—Classes of bricks and their distinguishing qualities. Moulding. Drying and stacking. Brick-burning. Types of Kiln. Fire-bricks. Terra-cotta. Tile manufacture.

Cements, Limes and Mortars.—Use of mortar. Natural and artificial cements. Varieties of limes. Hydraulicity. Burning. Clamps, Kilns. Plaster. White-wash. Distemper. Concrete. Portland cement.

Timber.—Growth of trees. Felling trees. Classification and properties of Indian and other woods. Most suitable woods for particular purposes.

Stone Masonry.—Ashlar of various sorts. Block-in-course. Bond. Dressing stone. Rubble masonry. Safe loads. Lewis. Dowel. Joggle. Cramp. Template. Scaffolding. Shears. Derrick. Gyn. Gantry.

Brick Masonry.—Types and their uses. Bond. Closers. Bedding. Moisture Scaffolding. Precautions against settlement. Racking back. Plastering. Pointing. Coping. Cornice. Blocking course. Parapet. Eaves course. Corbel. Lintel. Jamb. Reveal. Sill. Footing. Drip-course. Pisé walling. Dhajji walling. Hollow masonry. Reinforced brick-work.

(*ii*) *Design of Structures.*

Buildings.—Design of a residential bungalow; with special reference to selection of site, construction of walls, damp-proof courses, water-supply, drainage and ventilation.

Fire-proof construction.

Reinforced brick-work design; beams, floors, etc.

Thomson's principles of similar structures as regards their strength, stability, deflections, etc.

Bridges.—Selection of site. Determination of discharge of river by consideration of area of watershed, intensity of rainfall, and by zoning. Waterway to be provided. Depth of scour.

Design of foundation. Box; crate; well; pile; continuous masonry; reinforced concrete slab. Piers, ordinary and abutment. Floors and curtain walls.

Reinforced Concrete.—Nature, uses, properties, advantages and disadvantages of Reinforced Concrete over other types of construction. Assumption made in theory of stress in reinforced concrete beams.

Theory and design of simple beams, T-beams and slabs for different conditions of loading.

(*iii*) *General Principles governing the design of Railways, Roads, Harbours and other works.*

Roads.—Formation and permanent way. Types of roadways. Hill roads. Ruling gradients. Resistance of vehicles. Drainage. Tramways.

Railways.—Formation and permanent way. Gauges. Tractive force. Tunnelling. Light railways and mountain railways.

River Training Works.—Spurs. Groynes. Bell Bunds. Streamlime Bunds. Mattresses. Aprons.

Miscellaneous.—Piles and pile-driving; sheet and screw piling. Diving operations, reclamations and dredging. Retaining walls. Depth of foundations. Counterforts and buttresses. Revetments. Construction and sinking of masonry wells. Simple masonry dams. Technical names of various parts.

Surveying.

Surveying.—Construction of Scales. Conventional signs. Use and adjustment of instruments. Theory of levelling; simple, compound, check and reciprocal levelling. Various causes of errors in levelling. Elimination of such errors. Customary limits for errors. Method of keeping various styles of field-books. Use of boning rods. Chain survey. Chain and compass survey.

Theodolite Traversing by Gale's traverse system for city and town improvement surveys. Source of errors and required precision in traversing. Traverse tables. Theory and use of the simple plane-table and tangent clinometer, with and without the magnetic compass. Theory and use of the stadia method of plane-tabling with levelled heights and reductions of distances and heights by slide-rule. The three point problem or plane-tabling by resection from within and without the triangle. Geometrical and trigonometrical proof of the three point problem. The two point problem with and without the magnetic compass. Triangulation with reciprocal values; heights of stations; base line measurements. Finding values of position by observations to three known points. Computation by rectangular co-ordinates with convergency correction.

Contouring of the triangulated area by heights calculated from the reduced levels. Longitudinal and cross-sections run with a level. The location on the map of a road, railway, canal or weir, etc. The general principles of tunnel alignment and of carrying surface meridians underground for mine-surveys. Discussion on the latest patterns of instruments.

Practical Astronomy.—Introduction to spherical trigonometry up to the solution of the spherical triangle, and the adaptation of Napier's rules of circular parts. Definitions; systems of celestial co-ordinates; the reasons for sidereal, sun and mean time; acceleration, retardation and equation of time. The Julian and Gregorian calendars; time and the various astronomical corrections.

Finding the meridian of a place by observations to the sun or a star at upper culmination, by equal altitudes, by the sun or stars not on the meridian, and by circumpolar stars at elongation; and finding time by the sun or stars on the meridian and ex-meridian; finding latitude by Polaris and circum-meridional observations. Use and construction of sundials.

Railway Curves and Alignments.—Theory of curves. Curves laid out with the aid of angular instruments; with one theodolite. Curves laid out by linear measurement only. By chords and offsets (several methods). By offsets inside the curve. Curve by ordinates from the long chord. Curve with certain given data to pass through a ruling point. Compound curves. Diversion curve. Vertical curves. Curve spiral or transition curve. Double centre method for laying out a straight line. Setting out pegs for earth work. Computation of areas of cross sections, etc.

Sanitary Engineering and Water Supply.

Water Supply. Source of Supply.—Springs; wells; rivers; lakes; choosing the supply.

Waterworks.—Intakes; settling tanks; filters; rates of filtration; various types of mechanical filtration.

Reservoirs.—Impounding, storage and service reservoirs; water-towers.

Pipes.—Rising mains; expansion joints; losses in head; valves; service-tanks; house-connections; meters; cisterns.

Pumping Installations.—General types of installations used in India.

Sanitary Engineering.—Water purification; natural waters, impurities present; methods employed for rendering natural waters potable; boiler-waters and softening agents; interpretation of analytical reports.

Sanitary laws; refuse removal and disposal; the chemistry of sewage; river-pollution and its effects; sewerage systems; sewers, their construction and ventilation; traps; house drainage; purification of sewage; chemical precipitation and precipitants; liquefaction of sewage; sewage-oxidation; irrigation and trenching; sewage farms; septic tanks; contract beds; the combined system; details concerning tanks, filters and filtration; distributors, etc.

Electrical Engineering.

Electric Units. Commercial electrical measuring instruments for D. C. and A. C., their action and use in D. C. and A. C. circuits.

Dynamo electric Machines. Physical principles and essential parts of both Generators and Motors. Description of the standard form of field. Description of armature, lamination and its object, lap and wave windings, action of the armature winding and commutator. Arrangements of induced E. M. Fs. in wave and lap windings.

Description of Commutator and Brush Gear. Discussion of sparking at brushes and methods of dealing with it by contact resistance and E. M. Fs. Interpoles Armature reaction.

Description of continuous current dynamos, series, shunt and compound wound. Method of regulating voltage, parallel running, characteristic curves.

Shunt and series motors and their working characteristics, Motor Starters, Losses in a motor and its Rating. Efficiency curves. Suitability of D. C. motor for different types of load.

Alternative current Principles graphical representation of an A. C. frequency, phase and effective value of current and voltage. Use of rotating vectors. Resistance. Inductance and capacity. Power factor. Three-phase circuits and measurement of three-phase power supply. Production of rotatory field. Star and mesh connections.

Description of single and three-phase generators. Synchronising and parallel running.

Description of single and three-phase motors. Induction motors. Squirrel cage and wound motors. Methods of starting.

Transformers. Convertors and Motor-Generators. General description and discussion of their action and construction.

Accumulators. Boosters. Installation and upkeep.

Switchboard and arrangement of measuring, controlling and protective devices for D. C. and A. C. supply.

Mechanism of distribution of electric supply—Busbars. Feeders. Distributors and internal wiring. Requirements to be satisfied by conductors used in distribution as regards voltage regulation, reliability and economy. Value of high tension, three-wire system Balancers. Comparison of D. C. and A. C. Systems of Transmission and Distribution as regards amount of copper required for mains.

Overhead and underground mains. Principal types of cables used. Types of poles and insulators, Lightning arrestors.

Voltage drop in the D. C. and A. C. circuits and Transmission Lines.

Insulation resistance and its measurement, the megger.

Calculation of size of conductors.

Three-phase Transmission and Distribution. Various systems in use.

Transmission lines and arrangements at Power and Sub-Stations.

Internal wiring for power and light. Various systems in use. Testing for insulation resistance and localisation of faults. Wiring rules.

General principles of electric lighting. Lighting of rooms and streets. Description of lamps and fittings in general use.

Electric heating apparatus.

Capital and maintenance costs. Cost of wiring per point. Systems of charging for electric energy.

M51PSC—144—25.9.30—GIPS

RULES FOR THE RECRUITMENT IN INDIA BY EXAMINATION FOR THE SUPERIOR TELEGRAPH ENGINEERING AND WIRELESS BRANCHES OF THE INDIAN POSTS AND TELEGRAPHS DEPARTMENT.

(Reprinted as amended up to August 1930.)

1. A competitive examination for admission to the permanent establishment of the Superior Telegraph Engineering and Wireless Branches of the Indian Posts and Telegraphs Department, shall be held in India at such time and place as the Governor General in Council may direct.

2. Of the total number of vacancies in a year to be filled in India by examination under rule 1, two-thirds will be filled on the results of the competitive examination in the direct order of merit, provided the number of candidates is declared by the Public Service Commission as having qualified by examination. The remaining one-third vacancies will be reserved by the Government of India to redress, so far as may be necessary, marked communal inequalities and any appointments, which it may be necessary to make on these grounds, shall be made by the Governor General in Council, after consultation with the Public Service Commission by direct nomination from among candidates who have attained the qualifying standard at the examination and have satisfied the Public Service Commission that they are in all respects suitable for employment in the Superior Telegraph Engineering and Wireless Branches of the Indian Posts and Telegraphs Department. Such vacancies, among the one-third reserved, as may not be required for the redress of communal inequalities or for which duly qualified candidates for direct nomination may not be forthcoming may be filled in the direct order of merit in which the candidates passed the examination.

3. From the list, prepared by the Public Service Commission, of competitors, who have in the opinion of the Commission attained the qualifying standard, candidates to the number of vacancies to be filled will be selected for appointment in the manner laid down in Rule 2 provided that the Government of India are satisfied that they are duly qualified in other respects. Should any selected candidate become disqualified, the Government of India will determine whether the vacancy thus created shall be filled or not ; in the former case where the vacancy occurs on account of the disqualification of a candidate selected for appointment in order of merit the candidate next in order of merit, and in other respects duly qualified, shall be deemed to be the selected candidate.

NOTE.—The examination will be a combined examination for the purpose of filling vacancies in the Indian Service of Engineers, the Indian Railway Service of Engineers and the Superior Telegraph Engineering and Wireless Branches of the Indian Posts and Telegraphs Department. A candidate may apply to be admitted as a candidate for all or any of these posts. If he wishes to be admitted as a candidate for more than one service or branch he should state this on his application form. In that case he need send in only one application form and undergo one examination by a Medical Board. He will be required to pay the fees mentioned in Rule 12 once only, and will not be required to pay a separate fee for each service or branch for which he applies. If he proves successful as a candidate for more than one service or branch he will ordinarily be assigned to that service or branch for which he expressed a preference at the time of his application, provided that the vacancies have not already been filled, but the Government of India reserve power to assign him to any service or branch for which he is a candidate if in their opinion the exigencies of the public service render this desirable. Candidates who are also candidates for a service or branch not included in these regulations should refer to the regulations specially applicable to that service or branch.

The maximum number of candidates to be admitted to the combined examination may in the discretion of the Governor General in Council be limited to such number not being less than 200 as the Governor General in Council may decide. If a limit is imposed the Public Service Commission shall select from among the applicants those who shall be admitted to the examination.

4. (1) A candidate shall apply to be admitted to the examination before such date and in such form as the Governor General in Council may direct. The application shall be made to the authority of the area in which his parents reside at the time of his application or have previously resided for a period of not less than 3 years or in which he has himself resided, otherwise than as a student at a University only, for a like period.

(2) The application shall be made, if based on residence in a Governor's province, to the Chief Secretary of that province, if based on residence in Coorg, the North-West Frontier Province, Delhi, Ajmer-Merwara, or British Baluchistan, to the Chief Commissioner concerned and if based on residence in a State in India to the Political Officer or Agent through the Darbar.

(3) No candidate shall make more than one application in respect of any one examination.

5. A candidate must be male who is either (*i*) a British subject of Indian domicile, who was, and whose father and mother were, born within His Majesty's dominions and allegiance, or (*ii*) a British subject of Indian domicile whose father was at the time of the candidate's birth and still is (or if dead, continued until his death to be) a British subject or a subject of a State in India, or (*iii*) a ruler or a subject of a State in India in respect of whom the Governor General in Council has made a declaration under Section 96-A of the Government of India Act.

6. A candidate must have attained the age of 21 and must not have attained the age of 25 on the 1st day of August* next preceding the date of the examination.

7. A candidate must be in good mental and bodily health and free from any physical defect likely to interfere with the efficient performance of his duties and a candidate who is found after examination by a Medical Board not to satisfy these requirements will not be accepted for admission to the examination.

8. A candidate must satisfy the Public Service Commission that his character is such as to qualify him for employment in the Indian Posts and Telegraphs Department.

9. A candidate must—

(*i*) hold the Engineering Certificate of the Thomason Civil Engineering College, Roorkee ; or

(*ii*) have passed parts A and B of the Associate Membership examination of the Institution of Engineers (India) ; or

(*iii*) have passed one of the Indian examinations mentioned in Appendix II;

(*iv*) have obtained an Engineering degree of one of the Universities mentioned in Appendix III under the conditions prescribed in that Appendix ; or

(*v*) have passed Sections A and B of the Associate Membership examination of the Institution of Civil Engineers ; or

(*vi*) have passed the Associateship examination of the City and Guilds Institute (Imperial College of Science and Technology, South Kensington) in Civil Engineering ; or

(*vii*) have passed the Associate Membership examination of the Institution of Mechanical Engineers or graduateship examination of the Institution of Electrical Engineers ; or

(*viii*) have passed the Associate examination of the Bengal Engineering College in Mechanical Engineering ; or

(*ix*) have obtained such other diploma or distinction in Engineering as the Governor General in Council on the advice of the Public Service Commission may decide to accept.

10. No candidate shall be admitted to the examination unless he holds a certificate given by the Public Service Commission of having been accepted for admission.

11. No recommendations except those invited in the form of application will be taken into consideration. Any attempt on the part of a candidate to obtain support for his application by other means may disqualify him for selection.

12. Candidates must pay the following fees :—

(*i*) Rs. 5 with the application form ;

(*ii*) Rs. 16 before examination by a Medical Board ; and

(*iii*) if accepted for admission to the examination, Rs. 75 within three weeks after the notification of acceptance.

No claims for a refund of these fees will be entertained.†

13. The examination will include the following subjects each of which will carry the number of marks shown against it :—

(*a*) *Compulsory*—

	Marks.
(1) English (including Essay and Précis Writing)	100
(2) General Knowledge.. ..	200
(3) Applied Mathematics ..	100
(4) Applied Mechanics (including Strength of Materials and Theory of Structures) ..	100
(5) Electrical Engineering ..	100
(6) Viva Voce	200

(*b*) *Optional*—

Not more than one of the following subjects :—

	Marks.
(1) Physics (including Electricity and Magnetism) ..	100
(2) Prime Movers	100
(3) Hydraulics and Hydraulic machines	100
(4) Construction	100
(*i*) Building materials.	
(*ii*) Design of structures.	
(*iii*) General principles governing the design of railways, roads, harbours and other works.	
(5) Surveying	100
(6) Sanitary Engineering and Water Supply	100

14. The standard and syllabus of the examinations shall be such as the Public Service Commission shall prescribe and the Commission shall, if they think it desirable, determine what shall be the qualifying marks in all or any of the subjects of examination.

15. From the marks assigned to candidates in each subject such deduction will be made as the Public Service Commission may consider necessary in order to secure that no credit is allowed for merely superficial knowledge.

16. If a candidate's handwriting is not easily legible, a deduction will be made on this account from the total marks otherwise accruing to him.

17. Credit will be given for good English including orderly, effective and exact expression combined with due economy of words in all subjects of the examination and not only in subjects which are specially devoted to English.

18. A list of the competitors shall be made out in order of merit as disclosed by the aggregate marks finally awarded to each competitor.

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* Note.—These qualifications apply whether or not the candidate is already in Government service.

† *See* Note to Rule 3.

APPENDIX I.

General Conditions of Service prescribed for Probationers in the Superior Telegraph Engineering and Wireless Branches of the Indian Posts and Telegraphs Department.

1. *Apprenticeship.*—Selected candidates will be appointed as apprentices for training in the Department for one year during which period they will receive a subsistence allowance of Rs. 200 a month. Those who pass the year of apprenticeship satisfactorily will be appointed on probation for one year as Assistant Divisional Engineers. Their confirmation at the end of that year will depend on the result of that probation and on their passing certain prescribed departmental tests.

2. *Provident Fund.*—Officers entering the Superior Telegraph Engineering and Wireless Branches will be eligible to join the General Provident Fund and will be governed by the rules regulating that Fund.

APPENDIX II.

List of Examinations.

Final examinations leading up to the following degrees:—

B.E. of Bombay University.

B.E. of Calcutta University (College of Engineering, Sibpur).

B.E. of Madras University.

B.Sc. (Engineering) of Benares Hindu University.

The examination for the certificate in Electrical Technology of the Indian Institute of Science, Bangalore.

APPENDIX III.

List of University degrees which will be recognised for admission to the examination.

Oxford.—B.A., with Honours in the Engineering Science Final Honours School.

Cambridge.—B.A., with Honours in Mechanical Science Tripos, or Ordinary degree (B.A.) in Engineering, provided the graduate has passed in the principal subjects, Engineering I, Engineering II, and Engineering III.

St. Andrews.—B.Sc. in Engineering (Honours or Ordinary degree).

Glasgow.—B.Sc. in Civil or Mechanical or Electrical Engineering, or in Naval Architecture (Honours or Ordinary degree).

Edinburgh.—B.Sc. in Engineering (Honours or Ordinary degree).

Dublin.—B.A.I. (Ordinary or with Honours in Engineering).

Durham.—B.Sc. in Civil, or Mechanical, or Electrical, or Marine Engineering, or in Naval Architecture (Honours or Ordinary degree).

London.—B.Sc. (Internal degree) in Engineering, Ordinary or with Honours [not including the B.Sc. in Engineering (Mining) or the B. Sc. in Engineering (Metallurgy)]. The External degree is also accepted to the same extent provided it is recognised by the Institution of Civil Engineers as exempting from Sections A and B of the A.M.I.C.E. examination.

Victoria University (Manchester).—B.Sc. in Engineering (Honours degree or Ordinary degree obtained in and after 1920). B.Sc. Tech. in Mechanical or Electrical Engineering (Higher Course degree or Ordinary Course degree with a First Division pass in the final examination).

Birmingham.—B.Sc. in Civil, Mechanical, or Electrical Engineering (Honours or Ordinary degree).

Liverpool.—B. Eng. in Civil, Mechanical, Electrical or Marine Engineering, or Naval Architecture (Honours or Ordinary degree).

Leeds.—B.Sc. in Civil, Mechanical or Electrical Engineering (Honours or Ordinary degree).

Sheffield.—B.Eng. in Civil, Mechanical or Electrical Engineering (Honours degree or Ordinary degree with a First Class in the final examination). A First Class in the final examination will not be required in the cases of degrees obtained in or after June 1930.

Bristol.—B.Sc. in Civil or Mechanical or Electrical Engineering (Honours or Ordinary degree).

University of Wales.—B.Sc. in Civil, Mechanical or Electrical Engineering.

National University of Ireland.—B.E.

Queen's University, Belfast.—B.Sc. in Engineering.

Aberdeen.—B.Sc. in Engineering (Honours or Ordinary degree).

NOTE.—The above degrees will be accepted only if taken after three years' study and the passing of the regular examinations in the several Universities. The conditions as to three years' study will not, however, apply to Indians who, having taken an Indian degree, which exempts them from part of the University course, shall have taken one of the above degrees in less than three years in accordance with the regulations of the University concerned.

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Syllabus of the Examination for the Indian Service of Engineers, the Indian Railway Service of Engineers and the Superior Telegraph and Wireless Engineering Branches of the Posts and Telegraphs Department in the compulsory and optional subjects.

Note.—There will be no practical examination in any of the subjects.

Applied Mathematics.

Statics.—Vectors. Notion of force. Gravitational or Engineer's unit of force. Various kinds of forces. Friction. Composition and resolution of concurrent forces. Moments. Parallel forces and centres of gravity. Couples. Conditions of equilibrium of non-current coplanar forces. Funicular polygon.

Kinematics.—Units of space and time. Rectilinear motion; motion of a projectile; angular motion; relative motion; simple harmonic motion.

Kinetics.—Newton's Laws. Absolute system of units. Linear momentum. Impact of elastic bodies. Impulse and impulsive forces. Angular momentum; moments of inertia and radii of gyration; impulsive torque. Centrifugal forces. Conical pendulum. Motion of the centre of mass. Cant on railway curves and banking of road-tracks. Hoop stress and stress in the rim of a fly-wheel.

Work, power, kinetic and potential energy. Principle of energy. Kinetic energy due to rotation. Work done by a couple. Principle of Virtual work. Simple machines, mechanical advantage, and velocity ratio. Stable and unstable equilibrium. Deflection in a framed structure. Oscillations. Simple and Compound pendulum. Units and dimensions.

Hydrostatics.—Fluid pressure, its transmission, and measurement; density; specific gravity; metric system of units; resultant pressure; centre of pressure; equilibrium of floating bodies; metacentre. Laws of Boyle and Charles. Mixture of gasses. Nature and action of simple hydraulic machines.

Applied Mechanics.

(a) *Buildings.*

Consideration of materials used in the construction of roof-trusses. Steel and timber. Determination of stresses in trusses by various methods. Dead-loads and wind pressures. Factors of safety and working stresses.

Design of roof-trusses. Various types of roof-trusses and roof coverings; collar beam and hammer beam trusses.

Use of Euler's, Gordon's, Rankine's, Fidler's, Johnson's and straight line formulæ in the design of struts. Buckling factor of struts; curves showing comparative strength of struts obtained by various formulæ. Choice of size of sections. Finish of steel work. Joints. Design of end-bearings; methods of fixing and supporting ends.

Application of circle and ellipse of stress and Clapeyron's theorem to design of structures.

Cast Iron and Steel Columns.—Flange and web connections to steel columns; caps; bases; transverse bracing of columns.

Foundations.—Safe pressures; foundations for columns. Slab foundations; cantilever foundations; grillage foundations. Wells. Piles.

Retaining Walls and Earth-pressures.—Rankine's theory, Wedge theory, Winkler's and Bligh's graphical constructions, with corrections. Design of various types of retaining walls in masonry.

Tall Masonry and Steel Chimneys.—Theory and design.

Design of steel and masonry reservoirs; with considerations of wind-pressures.

Deflection of framed structures and determination of stresses, etc., in redundant frames.

Influence diagrams for bending moment and shear for uniformly distributed and irregular loads on trusses, built-in beams, and three-pinned, parabolic, semi-elliptic and semi-circular arches.

General principles of dome design.

Principles of Building Design; consideration of loads on buildings. Steel-work, girders, etc., for buildings.

(b) *Bridges.*

Design of superstructure. Determination by graphical and analytical methods of bending moment due to moving loads. Wind-pressures.

Design of masonry bridges and culverts.

Plate-web girders. Analysis of stresses.

Warren and lattice girders.

Three-pinned arches; doubly pinned and rigid arches.

General considerations on the design of suspension, cantilever, and tubular bridges.

Steel-arched bridges.

Swing bridges.

(c) *Reinforced Concrete.*

Shear, bond, and diagonal tension, its nature, evaluation and location of reinforcement.

Design of simple and doubly reinforced beams, and continuous beams.

Theory and design of reinforced concrete columns and piles.

Design of slab foundations.

Design of simple cantilever and counterfort retaining walls.

Equivalent moments of inertia for reinforced concrete sections.

Theory of elastic deflections and outline of investigation of stresses in reinforced concrete arches.

(d) *General.*

Analysis of stress, analysis of strain, elastic limit and ultimate strength. Relation between

the elastic constants. Launhardt-Weyrauch formula for working stresses in a structural member and determination of its cross-sectional area. Repetition of stresses. Bending moment and shearing force diagrams for dead loads. Graphical determination of stresses in frames; effect of wind pressure; method of sections. Stress in the cross-section of a beam due to bending (M/I-f/y-E/R); compound and conjugated stresses. Rankine's theory of earth-pressure; depth of foundations and strength of footings. Grillage foundations; Coulomb's theory of earth-pressure; modification due to Rebahn.

Bending moment and shearing force diagrams for live loads. Analysis of uniform and uniformly varying stress. Elastic theory of bending of beams; bending and shear stresses in beams. Modulus of section and equivalent areas. Maximum and minimum stresses in a joint due to eccentric loading. Stresses in dams and chimneys. Stability of block-work structures. Design of rivetted joints and stresses in boiler shells. Euler's theory concerning struts; modifications due to Rankine, Gordon and others. Torsion. Combind torsion and bending deflections. Encastre beams. Continuous beams and theorem of three moments. Elastic theory of arches. Masonry arches.

Physics (including Electricity and Magnetism).

Heat.—The methods of calorimetry and thermometry. Vapour-pressures, critical temperature and pressure. Conduction and diffusion of heat and the determination of constants. Radiation and absorption; laws of cooling. Theory of exchanges; methods of measuring radiation. Laws of thermodynamics; simple applications.

Light.—Velocity of light. Illumination; photometry. Achromatism in lens systems; direct-vision spectroscope.

The wave theory; simple interference phenomena. Huygens' principle explanation of straight line propagation, reflexion, and refraction of light. Action of mirrors, lenses, etc., reviewed from this standpoint. Simple diffraction phenomena. Gratings and wave-length determination. Spectrum analysis; Doppler's principle. Double refraction and polarization of light; rotatory polarization; simple applications.

Magnetism.—Forces on a magnet in a magnetic field. Determination of axes and moment of magnet. Magnetic potential, level surfaces. Interaction of two short magnets; determination of filed strength. Magnetic shell; its potential energy in magnetic field. Total normal induction Gauss' theorem; number of lines of force. Magnetic induction in iron, etc. Theory of magnetism.

The magnetic field of the earth; the elements and their variations; the compass and its corrections.

Electricity.—Electric capacity; specific inductive capacity. Distribution of electricity on surface of conductors; images. Value of electric force in simple cases of distribution. The mechanical force on charged conductors; energy of electrified systems. The dielectric medium; dielectric displacement currents.

Wheatstone's bridge; specific resistance; resistance thermometers. Conductivity of electrolytes; ionization; migration phenomena; accumulators. Standard cells; the potentiometer system of measurement. Thermo-electricity; application of thermo-dynamics; thermo-electric diagrams. Electro-magnetic induction; coefficients of induction; induction coils. Energy of circuit carrying current when placed in a magnetic field; mechanical force on conductors carrying current; moving coil instruments. Lenz's law; illustration from dynamos and motors, etc. Determination of current resistance; E. M. F. in absolute measure. The discharge of a condenser; electric waves. Elementary theory of the electron.

The elementary theory of the continuous current dynamo and motor, and of the alternating current dynamo. General Principles of the application of electricity to lighting power-transmission, telegraphy, etc.

Sound.—The transmission of energy through material media by wave-motion; speed of propagation of waves of permanent type. Nature of musical sounds; pitch; scales. Reflection and refraction of sound; influence of wave-length. The vibration of strings, bars, plates and gas columns; resonance. Interference and diffraction phenomena. Analysis of sound. Measurement of wave-length, velocity and pitch.

Prime Movers.

Fuel, Gas Plants and Boilers—

Fuel. (*a*)—Coal, wood, petroleum, gas, petrol, alcohol, etc.; physical characteristics; approximate chemical composition; heat of combustion.

(*b*) *Gas Plants.*—Gas-Producers; pressure and suction plants; arrangement and working.

(*c*) *Boilers.*—Draught; natural, forced and induced. Ordinary forms of stationary, locomotive, marine, water-tube, and other types; heating surface, fire-grate area; boiler efficiency; superheaters; feedwater heaters; accessories and management.

Theory of Heat Engines—

(*a*) Thermodynamical principles; Carnot's cycle; perfect heat engine; second law.

(*b*) *Air Engines.*—Stirling and other forms.

(*c*) *Internal Combustion Engines.*—Gas, oil and petrol engines; engines with fluid pistons; types and working; features of cycles. Proportioning of mixtures; efficiencies.

(*d*) *Steam.*—Thermodynamics of the generation, expansion, and condensation of steam; heat diagrams, etc.

(*e*) Steam Engines and turbines, with special reference to modern developments.

(*f*) *Refrigerating Plant.*—Theory and general arrangement of the more common types.

(*g*) *Air Compressors.*—Theory of pneumatic working.

Generating Plants, Accessories and Details—

(*a*) General arrangements and construction of the more important types.

(*b*) Condensers, air-pumps, circulating pumps, cooling tanks, etc.

(*c*) Carburettors, and systems of ignition.

(*d*) Cylinders, pistons, crossheads, guides, connecting rods, cranks, governors, fly-wheels, valves and valve gears, glands and pipes.

(*e*) *Engine-Testing.*—Consumption of steam and fuel, gas and oil; brakes and dynamometers; indicators, and indicator diagrams.

Hydraulics and Hydraulic Machines.

Hydraulics.—Definitions relating to flow of water; stream-line motion Bernoulli's theorem Venturimeter.

Flow of water through small and large orifices; drowned orifices; sudden enlargements and contractions in flow of water. Time of emptying tanks. Flood absorptive capacity of tanks.

Flow of water over notches and weirs.

Flow of water through pipes; hydraulic gradients; losses of head due to bends, contractions and sudden enlargements; losses of head through siphons. Impacts at bends and thrust-blocks.

Flow of water in open channels and in pipes; Chezy, Basin, Kutters, and other formulæ and their applications; cross sections of greatest efficiency.

Calculations of afflux and back water curve.

Gauging the flow of water in open channels water-meters.

Hydraulics and hydrostatics of weirs and other canal works.

Hydrokinetics; uniform and steady flow; stream-line and turbulent motion. Bernoulli's theorem and its application.

Discharge through orifices and mouth pieces, and over notches and weirs. Variable heads. Laws of fluid friction. Head lost due to friction.

Hydraulic Machinery.—Impact of water on fixed and moving vanes. Turbines; impulse and reaction. Description of different types of turbines. Determination of vane-angles. Efficiencies of turbine plant. Governing.

Pumps.—Reciprocating, centrifugal and turbine.

Construction.

(*i*) *Building Materials.*

Stone.—Selection. Characteristics. Indian and European stones. Quarrying. Blasting. Dressing stone. Implements.

Bricks and Tiles.—Classes of bricks and their distinguishing qualities. Moulding. Drying and stacking. Brick-burning. Types of Kiln. Fire-bricks. Terra-cotta. Tile manufacture.

Cements, Limes and Mortars.—Use of mortar. Natural and artificial cements. Varieties of limes. Hydraulicity. Burning. Clamps, Kilns. Plaster. White-wash. Distemper. Concrete. Portland cement.

Timber.—Growth of trees. Felling trees. Classification and properties of Indian and other woods. Most suitable woods for particular purposes.

Stone Masonry.—Ashlar of various sorts. Block-in-course. Bond. Dressing stone. Rubble masonry. Safe loads. Lewis. Dowel. Joggle. Cramp. Template. Scaffolding. Shears. Derrick. Gyn. Gantry.

Brick Masonry.—Types and their uses. Bond. Closers. Bedding. Moisture Scaffolding. Precautions against settlement. Racking back. Plastering. Pointing. Coping. Cornice. Blocking course. Parapet. Eaves course. Corbel. Lintel. Jamb. Reveal. Sill. Footing. Drip-course. Pisé walling. Dhajji walling. Hollow masonry. Reinforced brick-work.

(*ii*) *Design of Structures.*

Buildings.—Design of a residential bungalow; with special reference to selection of site, construction of walls, damp-proof courses, water-supply, drainage and ventilation.

Fire-proof construction.

Reinforced brick-work design; beams, floors, etc.

Thomson's principles of similar structures as regards their strength, stability, deflections, etc.

Bridges.—Selection of site. Determination of discharge of river by consideration of area of watershed, intensity of rainfall, and by zoning. Waterway to be provided. Depth of scour.

Design of foundation. Box; crate; well; pile; continuous masonry; reinforced concrete slab. Piers, ordinary and abutment. Floors and curtain walls.

Reinforced Concrete.—Nature, uses, properties, advantages and disadvantages of Reinforced Concrete over other types of construction. Assumption made in theory of stress in reinforced concrete beams.

Theory and design of simple beams, T-beams and slabs for different conditions of loading.

(*iii*) *General Principles governing the design of Railways, Roads, Harbours and other works.*

Roads.—Formation and permanent way. Types of roadways. Hill roads. Ruling gradients. Resistance of vehicles. Drainage. Tramways.

Railways.—Formation and permanent way. Gauges. Tractive force. Tunnelling. Light railways and mountain railways.

River Training Works.—Spurs. Groynes. Bell Bunds. Streamlime Bunds. Mattresses. Aprons.

Miscellaneous.—Piles and pile-driving; sheet and screw piling. Diving operations, reclamations and dredging. Retaining walls. Depth of foundations. Counterforts and buttresses. Revetments. Construction and sinking of masonry wells. Simple masonry dams. Technical names of various parts.

Surveying.

Surveying. Construction of Scales. Conventional signs. Use and adjustment of instruments. Theory of levelling; simple, compound, check and reciprocal levelling. Various causes of errors in levelling. Elimination of such errors. Customary limits for errors. Method of keeping various styles of field-books. Use of boning rods. Chain survey. Chain and compass survey.

Theodolite Traversing by Gale's traverse system for city and town improvement surveys. Source of errors and required precision in traversing. Traverse tables. Theory and use of the simple plane-table and tangent clinometer, with and without the magnetic compass. Theory and use of the stadia method of plane-tabling with levelled heights and reductions of distances and heights by slide-rule. The three point problem or plane-tabling by resection from within and without the triangle. Geometrical and trigonometrical proof of the three point problem. The two point problem with and without the magnetic compass. Triangulation with reciprocal value; heights of stations; base line measurements. Finding values of position by observations to three known points. Computation by rectangular co-ordinates with convergency correction.

Contouring of the triangulated area by heights calculated from the reduced levels. Longitudinal and cross-sections run with a level. The location on the map of a road, railway, canal or weir, etc. The general principles of tunnel alignment and of carrying surface meridians underground for mine-surveys. Discussion on the latest patterns of instruments.

Practical Astronomy.– Introduction to spherical trigonometry up to the solution of the spherical triangle, and the adaptation of Napier's rules of circular parts. Definitions; systems of celestial co-ordinates; the reasons for sidereal, sun and mean time; acceleration, retardation and equation of time. The Julian and Gregorian calendars; time and the various astronomical corrections.

Finding the meridian of a place by observations to the sun or a star at upper culmination, by equal altitudes, by the sun or stars not on the meridian, and by circumpolar stars at elongation; and finding time by the sun or stars on the meridian and ex-meridian; finding latitude by Polaris and circum-meridional observations. Use and construction of sundials.

Railway Curves and Alignments.– Theory of curves. Curves laid out with the aid of angular instruments; with one theodolite. Curves laid out by linear measurement only. By chords and offsets (several methods). By offsets inside the curve. Curve by ordinates from the long chord. Curve with certain given data to pass through a ruling point. Compound curves. Diversion curve. Vertical curves. Curve spiral or transition curve. Double centre method for laying out a straight line. Setting out pegs for earth work. Computation of areas of cross sections, etc.

Sanitary Engineering and Water Supply.

Water Supply. Source of Supply.—Springs; wells; rivers; lakes; choosing the supply.

Waterworks.—Intakes; settling tanks; filters; rates of filtration; various types of mechanical filtration.

Reservoirs.—Impounding, storage and service reservoirs; water-towers.

Pipes.—Rising mains; expansion joints; losses in head; valves; service-tanks; house-connections; meters; cisterns.

Pumping Installations.—General types of installations used in India.

Sanitary Engineering.—Water purification; natural waters, impurities present; methods employed for rendering natural waters potable; boiler-waters and softening agents; interpretation of analytical reports.

Sanitary laws; refuse removal and disposal; the chemistry of sewage; river-pollution and its effects; sewerage systems; sewers, their construction and ventilation; traps; house drainage; purification of sewage; chemical precipitation and precipitants; liquefaction of sewage; sewage-oxidation; irrigation and trenching; sewage farms; septic tanks; contract beds; the combined system; details concerning tanks, filters and filtration; distributors, etc.

Electrical Engineering.

Electric Units. Commercial electrical measuring instruments for D. C. and A. C., their action and use in D. C. and A. C. circuits.

Dynamo electric Machines. Physical principles and essential parts of both Generators and Motors. Description of the standard form of field. Description of armature, lamination and its object, lap and wave windings, action of the armature winding and commutator. Arrangements of induced E. M. Fs. in wave and lap windings.

Description of Commutator and Brush Gear. Discussion of sparking at brushes and methods of dealing with it by contact resistance and E. M. Fs. Interpoles Armature reaction.

Description of continuous current dynamos, series, shunt and compound wound. Method of regulating voltage, parallel running, characteristic curves.

Shunt and series motors and their working characteristics, Motor Starters, Losses in a motor and its Rating. Efficiency curves. Suitability of D. C. motor for different types of load.

Alternative current Principles graphical representation of an A. C. frequency, phase and effective value of current and voltage. Use of rotating vectors. Resistance. Inductance and capacity. Power factor. Three-phase circuits and measurement of three-phase power supply. Production of rotatory field. Star and mesh connections.

Description of single and three-phase generators. Synchronising and parallel running.

Description of single and three-phase motors. Induction motors. Squirrel cage and wound motors. Methods of starting.

Transformers. Convertors and Motor-Generators. General description and discussion of their action and construction.

Accumulators. Boosters. Installation and upkeep.

Switchboard and arrangement of measuring, controlling and protective devices for D. C. and A. C. supply.

Mechanism of distribution of electric supply—Busbars. Feeders. Distributors and internal wiring. Requirements to be satisfied by conductors used in distribution as regards voltage regulation, reliability and economy. Value of high tension, three-wire system Balancers. Comparison of D. C. and A. C. Systems of Transmission and Distribution as regards amount of copper required for mains.

Overhead and underground mains. Principal types of cables used. Types of poles and insulators, Lightning arrestors.

Voltage drop in the D. C. and A. C. circuits and Transmission Lines.

Insulation resistance and its measurement, the megger.

Calculation of size of conductors.

Three-phase Transmission and Distribution. Various systems in use.

Transmission lines and arrangements at Power and Sub-Stations.

Internal wiring for power and light. Various systems in use. Testing for insulation resistance and localisation of faults. Wiring rules.

General principles of electric lighting. Lighting of rooms and streets. Description of lamps and fittings in general use.

Electric heating apparatus.

Capital and maintenance costs. Cost of wiring per point. Systems of charging for electric energy.

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